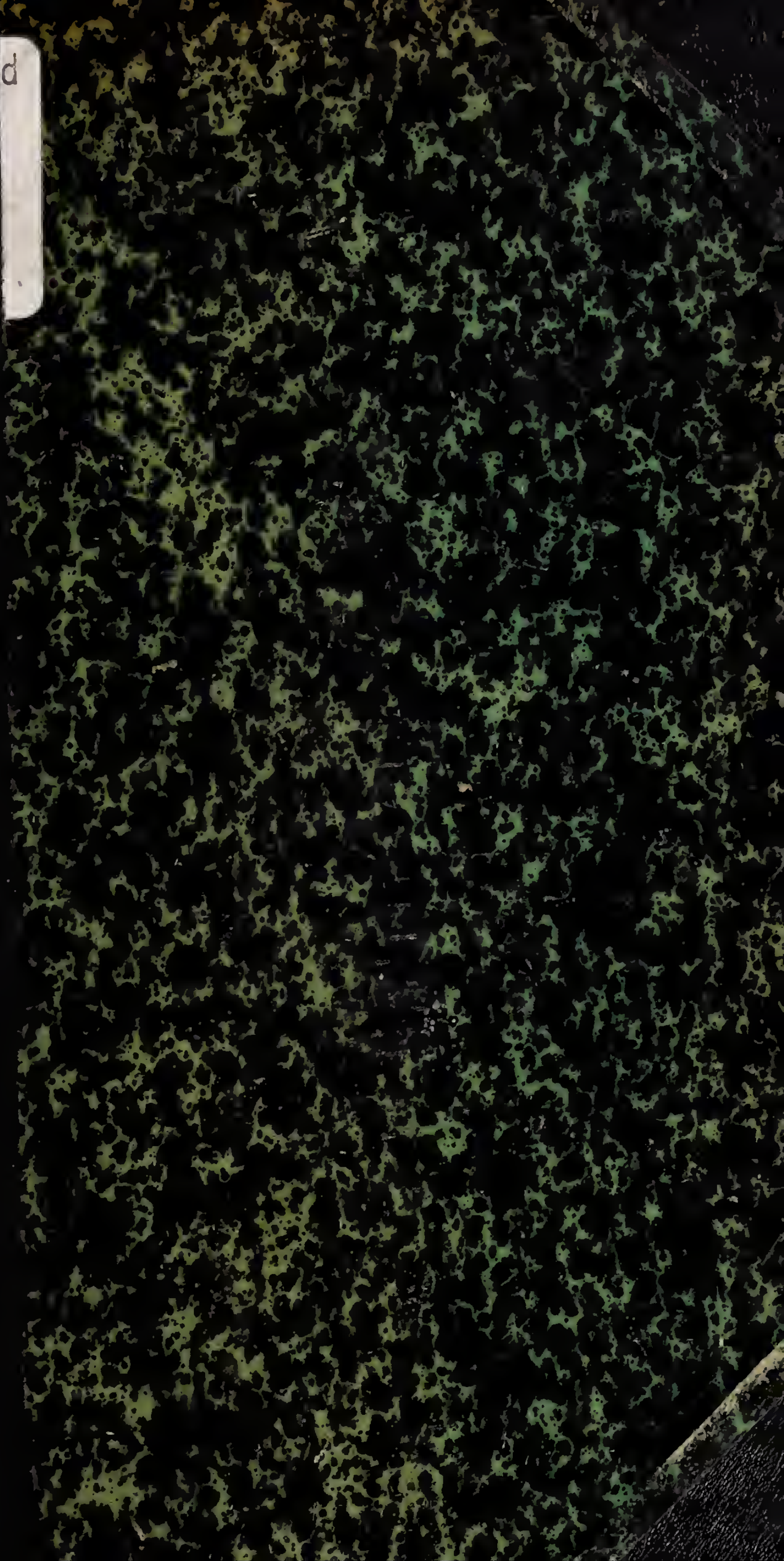

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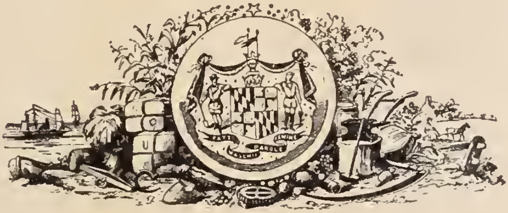
THE TWENTY-SECOND

ANNU[illegible]EPORT

OF THE

MARYLAND AGRICULTURAL EXPERIMENT STATION



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The Maryland Agricultural Experiment Station

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The Board of Trustees of the Maryland Agricultural College

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The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C. Bell Telephone, Hyattsville 55 R.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

Address

AGRICULTURAL EXPERIMENT STATION
College Park, Maryland

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LETTER OF TRANSMITTAL

To His Excellency, Austin L. Crothers, Governor, and President of the Board of Trustees, Annapolis, Maryland.

SIR: In accordance with the provisions of Section No. 3 of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty-second Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1909.

Very respectfully yours,

H. J. PATTERSON,

July, 1909.

Director of the Experiment Station.

THE MARYLAND

Agricultural Experiment Station

VOLUME 22 1908-1909

Report on the Work and Expenditures of the Maryland Agricultural Experiment Station and Recommendation for Enlarging its Sphere of Usefulness

For the Year Ending June 30, 1909

By H. J. PATTERSON, Director.

To the Honorable Board of Trustees of the Maryland Agricultural Experiment Station.

GENTLEMEN: I have the honor to submit herewith for your consideration some recommendations for enlarging the work of this institution so as to enable it to meet the demands already made upon it by the farmers of the state, and at the same time to cause this institution to become a great factor in developing Maryland's agricultural possibilities.

The present state administration and its Chief Executive, Governor Crothers, will ever be remembered for the position which has been taken to give this state *Good Roads*. There is nothing which could have been done that would do so much towards advancing the financial, educational, social and spiritual interests of the people. The next great step which can be taken, and which will make another epoch in our state's progress, is to develop and conserve our natural resources. The greatest natural resource in this state is unquestionably the soil. The development of this resource will be of inestimable value in increasing the revenues of this state, and in promoting the happiness of our people. I believe that the Maryland Agricultural College and Experiment Station, when fully equipped, can be a *great factor* for developing and conserving the agricultural resources of the state, and that a great opportunity rests with this Board of Trustees and the present State Administration to set on foot an active movement to this end. The expense involved in such a project will necessarily be large, but when all things are considered the total amount will be but a bagatelle when measured by the results attained. The guiding thought for the Board of Trustees of this institution, which is ex-officio the State Board of Agriculture, should be, not how little money you can exist on, but how much can be spent with profit to the industry and the people you represent. I believe that I am close enough to the farmers of this state to feel confident that such a policy will meet with their approval, even though it necessitated slightly increasing their taxes.

WORK OF THE INSTITUTION UNDER THE BOARD OF TRUSTEES

The work assigned to this Board of Trustees may be properly divided into five classes, viz:

1. Research or investigational work.
2. Demonstration work.
3. Extension or Farmers' Institute work.
4. Educational or school and college work.
5. Police control or inspection work.

There are certain phases of all of these lines of work that are distinct and must be conducted independently; but for the full development of all of them, so as to get the greatest benefits, they will necessarily overlap and consequenty should be developed coördinately and simultaneously.

The work of this institution should be regarded as a business or commercial proposition, and the people and their representatives should treat it on the same basis as a corporation and the directors of a corporation would treat a business proposition—for the state is really a big corporation of which the people are the stockholders.

RECOMMENDATIONS

In order to develop this institution in harmony with these ideas, I submit the following recommendations, and in doing so will state that I have no desire to trespass on the rights of other Departments, but only submit ideas which it would seem to me to be necessary for our mutual development. Most of these ideas, at the solicitation of the President of the College, have been presented to the farmers' organizations of the state and have been endorsed by them.

QUALITY OF INVESTIGATORS AND TEACHERS

In order that investigations of a high character may be conducted, and students and farmers have confidence in their instructors, it is very desirable, and I believe essential, that the work be done by thoroughly trained specialists.

Such men are scarce in every line of agriculture, hence much in demand, and they are commanding higher wages than is paid for teachers and investigators in many other fields.

The day for the general teacher in agriculture has past and those institutions which are keeping pace with the demands upon them are having their men specialize more and more.

For the gricultural and technical schools to follow such a course is only to do what the medical and law schools have been doing for many years.

I believe it is the exception, rather than the rule, to find men who are equally good as teachers and investigators, and I believe it is not for the best interest of the work to expect men to divide up their energies constantly. A man should be either mainly an investigator or a teacher, but for his own welfare, as well as the best interests of the institution, he should not wholly exclude the other. I believe every good teacher should be pursuing some investigation which he can follow at odd times, and I also believe that every investigator should give a course of lectures or instruction (possibly in some cases only one) to students, as this will enable him to collect his ideas and results and crystallize them into some tangible form. The agricultural investigator should also attend some farmers' meetings and visit some of the best farmers in his line, so as to keep him in touch with what the farmers are thinking about, see things from their point of view, and thus enable him to adjust his investigations accordingly. This teaching and institute work should be given, however, connectedly, and in a few days or weeks, so as not to be continually interrupting the investigations. This plan enables the heavy teaching work to be done by men who have that as their principal business, but it also enables farmers and students to be instructed by specialists in every sphere of agriculture.

The plan of thoroughly equipping the institution with a full corps of specialists will enable any student who desires to prepare to follow any specialty in farming to get instruction by a specialist and expert. This plan also would enable every farmer to consult such men when seeking advice and help.

SOIL FERTILITY

The fertility of the soil is the foundation of all successful agriculture, and while it is the oldest subject under consideration of the investigator, yet many questions remain unsolved and this station should considerably broaden and extend its investigations on increasing and conserving fertility and adapt them to all types of soils. The points that would seem to require immediate attention are as follows:

1. The rendering of plant foods available on different types of soils through crops and indirect fertilizers.
2. How crops should be used for increasing and conserving soil fertility.
3. The rate of diffusion and of depletion of lime and other alkalies in different types of soils.
4. The limits of profit in the use of relative amounts of plant foods in commercial fertilizers when applied to different types of soils.

Much demonstration and extension work on the question of soil fertility should be done so as to induce the mass of the farmers to practice better methods.

This subject is of sufficient importance to warrant the expenditure of many times as much as is now available for the work.

Crop Production

The station has already done considerable work on crop production, and we have at the present time two men devoted to this work, but when the acreage and annual value of the principal crops are considered I believe we would in reality be justified in having almost a man for each crop.

The total annual value of the products of Maryland farms is nearly 45 millions of dollars.

Maryland devotes to:

Crop	*Acres*	*Annual value of crop*
Corn	658,000	7½ millions of dollars.
Wheat	640,000	6½ " " "
Hay crops	425,000	5 " " "
Rye, Barley, Oats, Buckwheat, etc	100,000	1½ " " "
Tobacco	50,000	1½ " " "

When we consider the annual income that is derived from any one of the products that has been enumerated and then look at the average yields and how much these yields fall below what the most successful farmer gets, and what should be obtained to make the business profitable, we come to appreciate that investigations should be conducted which will locate the difficulties and determine the remedies. Such investigations should be conducted by the best talent that can be procured, and I am sure that a careful consideration of the subject would convince all, that every crop is of sufficient importance in our state to justify the employment of a specialist for investigating, demonstrating and teaching them.

To illustrate more in detail the commercial side of this question, or in other words reduce it to a business proposition, take the corn crop for example: The present average yield is only 30 bushels per acre, while good farmers get 50 to 75 bushels per acre. It has been demonstrated by investigations that the proper selecton of seed alone would increase the yield 2 barrels, or ten bushels, per acre, and this at this year's prices would have given Maryland farmers over three millions more dollars for their corn crop. I believe that by the expenditure of $5,000 to $10,000 per year in corn investigations and demonstrations alone, for five years, that the average yield of corn can be increased so that the annual revenue from this crop will be from two to five millions of dollars more than at present. Surely this is a business proposition which no corporation would turn down; then why should the people of the state? What can be done with corn can be accomplished on the same relative scale with the other crops.

ANIMAL INDUSTRY

Maryland devotes to:

Animal Products	*Capital Invested*	*Annual Production*
Horses	10 millions of dollars	2 millions of dollars.
Dairy cattle	4¾ “ “ “	5¼ “ “ “
Beef and miscellaneous cattle	2 “ “ “	
Hogs	1 “ “ “	4¾ “ “ “
Sheep	¾ “ “ “	
Poultry	¾ “ “ “	3½ “ “ “
Bees	⅛ “ “ “	40 thousand dollars.

The amount invested and the annual income from the animal products are much more than most people suppose, as the above figures will indicate.

The annual loss of animals through death is very great and much of this could be prevented by the proper use of immunizing serums.

The state should have a laboratory for the preparation of these materials so that the people of the state could avail of them at a nominal cost.

It is a rare thing to find a man who is an expert, or a successful breeder of al classes of animals. The dairy-man usually knows but little about horses, or sheep, and vice versa. Then why should we expect the best investigations or instruction to be given by a man who has to work with all classes. Surely the amount invested, the annual income, and the improvements which should be accomplished would justify having an expert in each class.

HORTICULTURAL WORK

The work in all departments of our institution should be placed on a high plane and the various departments well equipped so as to enable them to do thorough work; but natural conditions are such that this institution should aim to make its horticultural department particularly strong and build up a national, if not a worldwide, reputation for this phase of the work of the institution and the state. Because of our location, near Washington, and the wide range of horticultural possibilities in the state, this ambition for our institution is not too much to hope for, and I am sure is possible, but the opportunity is now ripe and if we are to compete for this prize we must act at once. Every university and experiment station of much note has made its chief reputation for some one or two things and I have been convinced for years that we should develop our horticultural work so as to make it second to none in the United States.

To do this effectually would require considerably more of an equipment than we have at present, and would necessitate having specialists in Pomology, Small fruits, Market garden crops, Floral culture, Greenhouse crops, Landscape gardening and Forestry.

The full development of the horticultural possibilities of Maryland, I am sure, would justify the expenditure of from 40 to 75 thousand dollars for a building and equipment, besides sufficient funds for maintaining the several departments enumerated.

Maryland devotes to:

Crop	*Acres*	*Annual value of crop*
Vegetables and flowers	100,000	4 millions of dollars.
Potatoes	40,000	1¼ " " "
Orchard fruits		1½ " " "
Small fruits		1¼ " " "

RURAL ENGINEERING, FARM ARCHITECTURE AND FARM MECHANICS

This state, and in fact the country as a whole, is very much in need of men trained especially as rural engineers, rural architects and in farm mechanics, and none of our institutions are instructing, demonstrating and investigating these questions as they should do.

We have nearly 400,000 acres of land in Maryland that is nearly worthless for the want of drainage that could be made very profitable for agricultural purposes if drained. Nearly 50 per cent of our farms have some lands on them which should be drained. The healthfulness of the state alone would justify the drainage of these lands, to say nothing of the increased agricultural value. Much money is now wasted by improper drainage and many hesitate to undertake the drainage of land for fear of failure because of insufficient knowledge.

Drainage should e investigated, demonstrated and taught by a skilled engineer who has had practical experience. It is not sufficient to simply know how to run a level.

Instruction in the building of country roads should be given by one who has had practical experience in such work. It is not sufficient to look at highways from the standpoint of railroad construction. Every community would be benefited if they could obtain just as good specifications for the proper practical expenditure of money on roads, whether they had only $25 per mile as when they have from $1,000 to $10,000 per mile.

Most farms could be much improved and labor saved by properly laying them out so as to have the fields conform to soil types, and the roads and buildings adjusted to the crop production.

There is a great need for training in the planning of farm and rural buildings. The best of architects are usually failures in planning a barn, or any other farm buildings. We need men to study farm buildings, and how to plan and construct them so that the farmer may know how to get the most for his money, no matter whether he has $25 or $5,000 to spend. We want farm architects that can plan according to the money allotted and not make the cost 30 per cent to 100 per cent more than was anticipated or desired.

In addition to the regular mechanical courses, there is a place for a course in pure farm mechanics as applied to all phases of farm operations and the handling of farm machinery.

In connection with such a course it would be well to have a place for a permanent exhibit of farm machinery which would serve for instructional and demonstrative purposes for students and for farmers at any time they should desire to visit the institution. Farmers could then study the points of merit in various makes of machines under the guidance of a disinterested instructor and expert. Such a department and exhibit would give opportunity for devising and testing machinery for different purposes and determining the relative draft and strength of a machine and its parts.

DEMONSTRATION WORK

Demonstration work can be made a very effective force for good in agricultural education. The results of many investigations must be presented in this form before many farmers will fully appreciate and adopt the results.

Demonstration work can be of two general characters, viz: One which will really be an extension work of the Experiment Station, and allow them to present the results of investigations by object lessons both at the Station and in different parts of the state. This class of demonstration is generally limited to a single operation at a time. A second class of demonstration work that could be made equally valuable for College and Station purposes would be to have demonstration farms in close proximity to the institution that could be operated on a definite plan which would be sanctioned by the results of investigations. These farms would have detailed records of all their operations which would be an open book for students and farmers who desired to study them. These farms would also serve as places where a limited number of students who so desire could "learn to do by doing." Such farms when equipped should be made more than self-sustaining. To illustrate, it would be feasible to plan a combined fruit and poultry farm which would be a college laboratory in these departments, a farm where the most approved methods could be followed, and also serve as a model or demonstration as to what a man might do with such a combination. There are several types of dairy farms, market garden farms, hog farms and sheep farms which might be planned for this kind of demonstration work.

If such a plan would seem feasible and desirable, it would be necessary to acquire land which would be adapted to the several types of demonstration farms, as the work already in hand is using all of the present farm and if much extension of the investigations is made more land will also be needed for these..

In addition to the classes of demonstration already suggested, every agricultural high school in the state should be provided with demonstration plots and fields, and the county poor-house farms should be used for demonstration purposes.

EXTENSION WORK

All kinds of extension work should be pushed so as to get farmers acquainted with the best methods. Results may be ever so valuable, but they will yield no profit if the farmers do not know of them or put them in practice.

The plan of conducting station extension work by having well-versed agricultural agents make a farm-to-farm visit should be given a trial in at least one district, if not one county, in the state. Such an agent, if he had a full appreciation of his job, would make practically every farmer he visited a friend of this institution, and awaken in him a new pride and interest in his work which would soon result in better agriculture and do much towards raising average yields.

CEREAL AND FORAGE CROP INVESTIGATIONS

The following is an outline of the experiments now in progress in this department and those to be started this season. The work in the main is the same as has been carried on the last two years. Some will be broadened out more while some, like the breeding of alfalfa and clover, will be reduced greatly. Alfalfa extension will be carried on as much as time will permit; this will be in coöperation with the U. S. Dept. of Agriculture. After the results of this season it is proposed to get all data on alfalfa ready for publication.

In addition to the coöperative testing of varieties of corn conducted last season seven more tests have been added: One at Adamstown, one at Frederick, one at Middletown, one at Westminster and three in Garrett County. In each test there are eight or more varieties. It is planned to start breeding tests sometime in the future (next year if possible) at Frederick, Westminster and in the Middletown valley. The main object of this is to develop improved strains and to interest farmers in these sections in growing pure seed. It is unfortunately true that at present it is impossible to get a sufficient quantity of seed of the two best varieties of Maryland white corn. Next year the station will probably have considerable seed corn of two or three varieties for sale, but the more satisfactory way will be to get farmers interested in the seed business and let it be the business of the station to keep pure and develop improved strains of seed. This ought to be true also of many of the other principal farm crops.

The three variety tests started in Garrett County are located near Oakland and at Accident. Eight or ten varieties collected from different sections of the United States which would seem to be suited for that section are being tested together with local types to determine which variety or varieties are best adapted to the high altitudes and shorter season of the western counties. Those which prove best will be used as a basis for further improvement by breeding and selection.

At present there are a great many notes on experiments in this department taken the past two seasons which have not been worked up. It is planned to get these worked up as soon as possible and prepare the results of all experiments which have progressed far enough or have been completed for publication.

The new investigations are the sweet corn breeding work turned over from the chemical department. This fall, experiments are to be started to determine the cause of alfalfa fields dying out suddenly and to determine if hairy vetch seed can be grown profitably. There are many more new lines that ought to be taken up, but with the present facilities the additional new work planned is about all that can be taken up and carried through properly this season.

Other lines of work which ought to be started this season are investigations of buckwheat and of oats in the western part of the state. Probably the best way to start these investigations is to first conduct a variety test of each crop. There are now at least four or five varieties of buckwheat grown, but no one seems to be able to state definitely why a particular variety is preferred, or under what conditions each is best suited or if all are equally well suited under all conditions. The same is true of oats. After the variety test or in connection with it, other investigations can be taken up. Such as the selection of pure and better strains, cultural and harvesting methods, etc.

The question of what crops to grow and how to handle them to the best advantage when used for green manuring to bring up the fertility of poor land is asked by hundreds of farmers. This is one of the most important problems to work out. But this problem should not be undertaken until the proper facilities and enough funds are available to carry the investigations through for a number of years. The nature of the problem is such that little valuable data can be secured unless the investigations are thorough, complete, and extend over a period of four or five years.

An Outline of the Investigations Conducted by the Department of Agronomy

The work now conducted in this department is a continuation of that outlined in the Twenty-first Annual Report, together with new lines of investigation.

The following is an outline of the old work now in progress and the new lines of investigation taken up this season:

CORN

1st. Breeding of Leaming and Munnikhuysen corn.

2d. Testing of the degree of inbreeding or close breeding, which may be safely practiced.

3d. Testing Leaming seed from different sources.

4th. Variety tests at the Experiment Station, including 2 varieties.

5th. Coöperative variety tests with 12 farmers in different parts of the state.

6th. Rate of planting test, with 3 varieties.

SMALL GRAINS

1st. Wheat: (*a*) Breeding plots of Currell and Fultz. (*b*) 101 variety and selection plots.

2d. Fall Oats: 13 variety plots.

3d. Barley: 8 variety plots.

4th. Spelt: 6 variety plots.

5th. Emmer: (*a*) 2 variety plots. (*b*) 6 rate of seeding plots.

ALFALFA

1. Breeding for seed producing strains.
2. Testing seed from different sources.
3. Fertilizer tests.
4. Cutting experiments.
5. Date of seeding experiments.

CLOVERS—RED, MAMMOTH, ALSIKE AND WHITE

1. Breeding.
2. Tests of seed from different sources.

COW PEAS

1. Breeding plots of three varieties.
2. A variety test.
3. A study of the methods of harvesting and threshing cow-pea seed.
4. A test of corn when grown with and without cow peas.

NEW WORK

Breeding two varieties of sweet corn, Country Gentleman and Stowell's Evergreen:

1. For a higher percentage of sugar.
2. For a higher yield.
3. For uniform white color of cob and silk.
4. A study of the relation of physical character and sugar content.

Experiments to determine the cause of alfalfa fields dying out suddenly.

An experiment to determine if Hairy Vetch seed can be grown profitably.

BOTANICAL INVESTIGATIONS

The following investigations were pursued by the Botanical and Pathological department the past year:

1. Tests of the effect of various lime and sulfur sprays upon various crops, especially peach and plum; the valu of the same as fungicides and different methods of preparing the same.

2. Tests of iron sulphate and other chemicals as sprays for weed killing. The results give much promise in the use of iron sulphate, at least as a winter or early spring spray for chickweeds, etc., in grain, alfalfa, strawberries, etc., and probably for other purposes.

3. Investigations on the effect of various substances applied to plants internally. This was chiefly carried out by Mr. Barrows last summer and a considerable amount of data collected especially upon introducing substances through cut end of branches or roots, and upon the effect of salts upon plantains and other weeds.

4. A classification of the large collection of Maryland grasses made by the late Mr. Novik last summer has been begun.

5. Records are being made of all the information which can be obtained from various sources as o cause, prevalence, amount of injury and effective treatment of all economic plant diseases found in Maryland. In the "Report on Plant Pathology" for State Horticultural Society will be found the results of the work for 1908. This year (1909)

notes have been collected upon the occurrence of a great many diseases, chiefly in greenhouses, which have not been previously noted. These notes are being made with the idea of sometime issuing a bulletin on greenhouse diseases as a companion to Bulletin 119 on "Greenhouse Insects," but to make such work complete much study of the physiological diseases such as those occurring this winter on our greenhouse roses would have to be made.

Chemical Investigations

In the chemical department the time of Dr. Fetzer has been entirely devoted to the dairy investigations as outlined below. Mr. Broughton has taken care of the routine chemical work or analyzing miscellaneous samples and has devoted as much time as possible to studies on the chemical and physical properties of unproductive soils, and upon the rate of diffusion of different forms of lime in different types of soils.

DAIRY CHEMISTRY

The work which occupied the time of the chemical department has been mostly with problems relating to the sanitary production of milk. It was in a great measure a continuation of the work originally begun two years ago and which consisted of pathological and physiological studies of milk and milk secretion.

In addition to the above there has been begun a microscopical and cell histological study of Colostrum. The question of the microscopy of the colostrum constituents is one which is quite unsettled, and in order to get at a good and sound solution of the leucocyte problem we must at least have a sound understanding of the colostral elements. It, therefore, seems important that this study be continued at such a time when it will not interfere with other work.

Other work which has been done and finished is "The effect of lime water on the digestibility of milk." This is being prepared for publication.

Some work has also been done with milks with a view of determining the possible cause of the improper emulsification or homogenization of milk during the course of preparing the so-called "clarified milk." So far this question appears to be one of a purely physical nature and which can be amply shown experimentally by passing an oily substance plus water through a filter paper—the oil, however, being previously incorporated with a calcium phosphate salt.

It is proposed for the coming year to continue the milk analyses in connection with the leucocyte work and to make only such determinations of substances as have been found to vary under the different conditions.

In this study the veterinary department will examine all samples of milk microscopically and the nature and amount of the cellular elements contained therein ascertained simultaneously with the chemical analysis.

Dairy Investigations

The dairy department of this station has during the fiscal year completed and compiled results for publication of three lines of investigations as follows:

1. The Manufacture of Sweet Cream Butter.
2. Butter Making in Maryland.
3. Methods of Whipping Cream.

Investigations are now being conducted to ascertain the sources of contamination of milk as it is produced at the dairy barn; effect of velocity and direction of wind blowing from some sources of contamination, and effect of humidity of atmosphere on such contamination.

Entomological Investigations

The importance of a knowledge of insects is being recognized more and more by the general farmers and horticulturists of this state as of great benefit and in many cases as absolutely necessary to successfully produce certain farm crops. Indeed the health of the home and community, it has recently been learned, is dependent upon a proper understanding of the habits and control of many household pests. The field for investigation and study of these little creatures is ever increasing.

While the work of this department since its inception has been largely associated with the horticultural interests of the state, chiefly on account of the legislative act creating it, yet the work should not be restricted but the equipment and funds should be sufficient to look after insect troubles with all crops.

During the past year an outbreak of the Angoumois grain moth in Maryland caused damage to wheat in two counties, amounting to approximately twenty-five to thirty thousand dollars. This and what may be called the wholesale importation of nests of the notorious brown tail moth may be considered the most notable entomological features of the past year. It is indeed fortunate that the state was in position to act immediately in the protection of her agricultural and horticultural interests by the inspection of all imported nursery stock to prevent as far as is possible the escape of this the most destructive and otherwise noxious insect pest that this country has ever experienced.

A summary of the investigational work in progress is as follows:

TEST OF SPRAY MIXTURES

The necessity of annually treating fruit trees for the control of the San José scale results in a continued interest among fruit growers as to the effectiveness of the new washes that are constantly being put on the market. While the home-made lime-sulfur solution is generally accepted as being the most satisfactory solution to employ, the difficulty attending its preparation and application is reason for the demand for a solution which may be more easily handled and applied and at the same time be equally as effective and not injurious to the tree. In order to be able to intelligently answer the inquiries as to the usefulness of the many new patent washes that are being put on the market, it seems necessary to continue the actual testing of these solutions on a practical basis. The past spring two orchards have been selected in which to conduct these tests, namely, one at Boonsboro and one at Chestertown. Twenty-one solutions were applied in like manner and at about the same time in these orchards. In all 1700 trees have been treated with these different solutions.

CODLING MOTH

For the past three years experiments have been conducted with a view of determining the actual benefit that will be derived from treating apple trees for this pest. A study of the life history of this insect for Maryland has also been conducted along with the investigation. This past season the work has been enlarged and eleven different orchards are being employed for the work. In some of these the spraying has been done simply with a view of showing the neighborhood the possibilities derived from the treatment. As far as possible the orchards have been selected on the poor-house farms in the state. Only seven counties have accepted the proposition; namely, Wicomico, Worcester, Kent, Washington, Frederick, and Allegany. In the other counties there were no orchards on the poor-house farms or the commissioners were not sufficiently interested to coöperate.

WOOLLY APHIS AND GREEN APHIS

The work in the control of the woolly aphis has been continued. Two acres of ground have been selected in each of the two largest nurseries in the state and the seedlings put out have been treated with various strengths of tobacco dust. Likewise experiments will be conducted against the green aphis which is such a common pest throughout the state attacking various fruit trees. Experiments with tobacco decoctions and kerosene emulsions are being conducted with a view of seeking the best remedy for these plant lice.

ASPARAGUS BEETLES

The experiments inaugurated last year against the asparagus beetles will be continued this year. These tests have been conducted in co-operation with the Bureau of Entomology, U. S. Dept. of Agriculture, Washington D. C. Eight different treatments of spray solutions were employed with a view of seeing which would be most satisfactory.

FLEA BEETLES

This common pest of truck crops continues to serve as a very troublesome factor to many of these crops which are grown on such a large scale in this state; namely, tomatoes, melons, etc. Seventeen different tests for the control of these were made last season upon cucumbers and melons on the Station farm. The abnormal season caused the results to be inconclusive. It is therefore expected to duplicate these tests this coming summer.

PLUM CURCULIO

Experiments conducted for the past three years employing different spray solutions for the control of the pest will be continued this year, although it is possible that the killing of the fruit by frost will cause inconclusive results as has resulted in previous year's work. Last year excellent results were secured from spraying for the pest but the work was not considered to be sufficiently extensive to justify publication of results. This year the tests have been extended to include the treatment of summer apples, inasmuch as serious injury is occasioned each year to this fruit, in various parts of the state, by the curculio. It is therefore an annual pest to plums, peaches and apples, and it is hoped that the results from these tests in the near future will be conclusive.

PEACH-TREE BORER

This likewise is an experiment that has been conducted for the past two or three years on a rather limited scale. The subject is deserving of an extended investigation looking toward a more practical means of control than worming. Twenty different materials and solutions have been used upon the trees with a view of seeking some one which would be effective in preventing the adult moths of the insect depositing their eggs upon the trunks of the trees. As yet negative results have been secured.

DIPPING OF FRUIT TREES

While it was thought that the results of dipping experiments conducted by the department the past four years were sufficiently conclusive to publish in Bulletin No. 131 showing principally the inadvisability of such treatment, yet the varying results secured justify a further investigation of the treatment before it is either condemned or recommended for general use. It is therefore hoped to continue tests of dipping fruit trees in various solutions under different conditions this coming year.

HONEY BEES

Through the coöperation of the Bureau of Entomology, U. S. Dept. of Agriculture, an investigation of the bee-keeping industry of the State has been inaugurated during the past year. This investigation has taken the form of first learning the status of the bee-keeping interests in the state with a view of aiding bee keepers by givng them such information as will promote bee keeping. It is found that the dreaded diseases, American foul brood and European foul brood, exist in apiaries in different parts of the state. If some attention is not given to the control of these diseases the industry will be wiped out. There are now about 18 states in the Union which have laws governing the inspection of apiaries for these diseases, and it is hoped that means can be provided whereby assistance can be given the bee keepers of Maryland with a view of exterminating the diseases or reducing their occurrence as much as is possible. I am pleased to report that through the efforts of this department a State Bee Keepers' Association has been formed which has for its aim the promotion of the industry in the state.

HYMENOPTEROUS PARASITES

The following brief statement by Mr. A. B. Gahan who is working exclusively under the funds of the Adams act, will give the status of his work during the past year and plans for the future.

The investigation of hymenopterous parasites has proceeded along the following lines:

1. Rearing, collecting and mounting of parasites from as many different sources as possible.
2. Identification and classification of species collected as well as those already in the collection.
3. Description of new species.
4. Securing of notes on the habits and life histories of the different species new and old wherever possible.
5. Cataloguing of information obtained.
6. Incidental observations on life histories, habits, etc., of hosts and predaceous insects affecting same.

This work has entailed the collecting of rearing material, the mounting, preserving and examining of approximately 1500 specimens.

Horticultural Investigations

A few lines of work were completed and the results were published in Bulletins 132 and 133, the former on Irish potatoes and the latter on cabbage. The commercial fertilizer experiment on peaches with W. F. Allen at Salisbury was necssarily discontinued because the trees were taken out owing to the presence of San José scale. The truck crop experiment with Leo A. Cohill at Hancock could not be continued during 1909 owing to the increased amount of orchard spraying which required the time that was formerly given to this experiment.

A few varieties of English muskmelons were tested in the greenhouse during the winter.

The following lines of work are being carried on with fruits, nuts, vegetables and flowering plants.

Apples:

(1) Experiments with commercial fertilizers and cover crops in the orchards of:

(*a*) E. P. Cohill, Hancock.
(*b*) W. G. Dawson, Cambridge.
(*c*) J. S. Harris, Coleman.

(2) Breeding: Owing to very heavy freezing weather during April and earlier in the spring, most of the buds were killed on the varieties desired for breeding purposes and cross pollination was done on only 78 flower clusters.

The number of seeds secured in 1909 was 796, most of which have germinated.

(3) Cover crops in Experiment Station orchard.

(4) Spraying with different strengths of Bordeaux to find out with which strength the most fruit is held to the trees. The entomologist is using poisons in various strengths in connection with this work.

PEACHES

Variety testing orchards—100 varieties in each of two orchards.

(*a*) E. P. Cohill, Hancock.

(*b*) W. F. Allen, Salisbury.

PEARS

Breeding work. Pear blossoms were nearly as badly killed by freezing as were apple blossoms, so that only 145 blossom clusters were cross pollinated.

In 1908 the seeds obtained in pear breeding numbered 2112, of which 934 have germinated.

PAW-PAW

Several hundred seedlings from choice strains of fruit are being grown.

RASPBERRIES

Experiments in pruning and training and in distances apart of plants.

STRAWBERRIES

(1) Variety testing—about 150 varieties are in the testing beds.

(2) Mulching and spring cultivation tests.

(3) Improving varieties by seed selection.

(4) Testing preserving fluids to retain color and shape of berries.

PECANS

(1) Encouraging the planting of nut trees by the distribution of 1100 pecan trees of the best varieties over the entire state.

(2) Top and root pruning pecan trees at time of planting.

(3) Planting 90 pounds of pecan seed to obtain seedling stocks for grafting purposes.

PERSIAN WALNUTS

(1) Grafting and budding Persian walnuts on stocks of black walnut, Persian walnut and butternut. The grafts number 252, the buds 84.

(2) Growing Persian walnut seedlings of the best varieties.

ASPARAGUS

Commercial fertilizer tests.

CABBAGE

(1) Variety testing.

(2) Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

(3) Saving seed from disease-resistant and unfavorable weather-resistant strains.

(4) Excessive amounts of plant food on seed beds to determine effect on growth and maturity of plants.

(5) Fertilizers applied early in spring for comparison with fertilizers applied when plants are set in midsummer.

CELERY

Growing seed from Golden Self Blanching for testing with California grown seed of the same variety.

IRISH POTATOES

(1) Investigating the causes which affect yields.

(2) Growing seed in Garrett County, Maryland, for comparison with Maine grown seed.

(3) Keeping seed in cold storage for planting in June and July.

(4) Testing seedlings.

(5) Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

(6) Variety testing.

MUSKMELONS

Testing rust-proof Rocky Ford strains.

ONIONS

Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

SWEET POTATOES

Growing continuously on same soil.

TOMATOES

(1) Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

(2) Feeding with copper solutions to induce disease resistance.

(3) Variety testing.

(4) Variation effects of the use of excessive amounts of gypsum, lime, sulphur, iron filings, copper sulphate, phosphoric acid, soluble and insoluble, dried blood, muriate and sulphate of potash.

CARNATIONS

(1) Experiments with carnation cuttings in relation to vigor of plants.

(2) Improvement by selected seedlings resulting from self-pollination.

(3) Fertilizer experiments using cow manure without bedding, with litter bedding and with sawdust bedding.

GERANIUMS

(1) Variety tests for vigor, hardiness and disease resistance.

(2) Breeding to produce varieties adapted to Maryland conditions.

(3) Application of Mendal's law.

(4) Study of color relations.

(5) Hybridization.

ROSES

(1) Methods of ventilation as related to prevalence of mildew.

(2) Fertilizer experiments using cow manure without bedding, with litter bedding, and with sawdust bedding.

VIOLETS

Comparison of rich and poor soils and manures.

FERTILIZERS

(1) Effects of fertilizers on the structure of plants.
(2) Variation of plants by excess of plant food in various forms.

FERTILIZING AND PRUNING

To investigate the causes of the doubling of flowers and seed cells of the ovaries in various plants.

Poultry Investigations

The work of the past year has been conducted according to the outline in the report for 1907–08, with the exception of Experiment No. 3 (the breeding of Barred Plymouth Rocks for egg production). This experiment was not fully planned at that time but has since been outlined and gotten under way. The experiments in progress at the present time are: Experiment No. 1, general test of poultry houses to ascertain if possible what type of house is best adapted to Maryland climate. Experiment No. 3, the breeding of Barred Plymouth Rocks for egg production. The work has been progressing very favorably, with the exception of some disease in the young stock during the summer of 1908 which was due to crowded conditions.

NEW WORK

During the year of 1907–08 a number of settings of eggs were sent to farmers in different parts of the state. The object in view was to introduce pure bred-stock, and to have the persons keep a careful record of the outgo and income, so as to give them an idea of the profit to be made from pure-bred poultry.

During the month of January the Poultryman spent several weeks visiting a large number of Maryland poultry farms. The object in view was to investigate the methods of those engaged in the industry, especially as to their commercial and practical value, so as to learn what factors contribute to success or failure. The trip was a success from every standpoint, and the data secured is now being prepared for publication.

During the spring a short series of lectures were delivered to the students of the Maryland Agricultural College and considerable interest was manifested on the part of the students.

IMPROVEMENTS FOR 1908-09

The brooder houses which were equipped with very small yards have been made more efficient by the addition of large commodious yards. A good substantial house has been erected for conducting Experiment No. 3, and has proven very satisfactory. A new gas machine and hot water heater have been installed in the basement of the main building, which have added greatly to the comfort and convenience of those carrying on the investigations.

The feed store room has been remodeled and a good cement floor and feed bins constructed.

The following donations were made to the poultry department the past year:

By the Boston Poultry and Dry Feed Hopper Co., Boston, Massachusetts:

12 large dry mash hoppers,
12 grit and shell hoppers,
12 chick hoppers,
1 large chick hopper.

By Cyphers Incubator Company, Buffalo, New York.

One 240, 1909 Model Incubator.
1 heating apparatus for old machine.

By Mandy Lee Incubator company.

1 Fireless Brooder.

By. F. W. Bird and Son, East Walpole, Mass.

Paroid and Red Rope roofing.

Tobacco Investigations

The tobacco investigations are being pursued in coöperation with the U. S. Dept. of Agriculture. They are being conducted at Upper Marlboro in Prince George's County, at La Plata in Charles County, and at Chaney in Calvert County. The work in general can be divided into six classes:

1. Testing of varieties.
2. Improvement by selection and breeding.
3. Fertilizer tests.
4. Crop rotation with tobacco the money crop.
5. Crop rotation with potatoes the money crop.
6. Test of the residual effect of fertilizers applied for tobacco upon the other crops in the rotation.

One of these series of plots is located on the farm of Mr. F. Sasscer, located at the Upper Marlboro station of the Chesapeake Beach R. R. This one should run for at least 6 years. Another is located on the Fair Association property. The new work begun this year has been laid out on the following plan:

1st. Beginning this year and each year thereafter for five years there will be started a new series of 20th acre fertilizer plots with tobacco, one half of each plot being limed, and all the plots of each series carried one or more times through a five-year rotation system, to determine the residual effects of the fertilizers used on the tobacco and also to get data and to serve as demonstrations of the advantages from the systematic rotation of crops arranged so as to intersperse the humus-giving and soil-improving crops with the soil-depleting crops; to furnish food for live stock in large quantities; and to give sources of money return other than from tobacco. The rotation system proposed is as follows:

1st year, *tobacco,* seeded to wheat in fall.
2d year, *wheat* separately seeded to grass in August.
3d year, *grass* for hay.
4th year, *grass* for hay.
5th year, *corn* with crimson clover.

The rotation will then repeat, beginning again with tobacco on the 6th year. It will be nine years before the series of fertilizer plots last started will have been through the full rotation. The only series of tobacco fertilizer plots conducted this year will be that at the foot of the hill opposite the last year's Fair Ground plots. The land planned to come in this work in 1910 will be plowed and seeded this year in cowpeas and crimson clover.

2d. Beginning this year and each year thereafter for five years, there will be started a new series of 20th acre fertilizer plots with potatoes, of both early and late varieties, one-half of each plot being limed and all the plots of each series carried one or more times through a complete rotation system identical with that proposed above for tobacco. Owing to the late start, the experiments with early potatoes will be omitted in 1909. Beginning with 1910, the plan is to have the fertilizer experiments with potatoes so arranged as to try out each fertilizer mixture after peas and crimson clover and after a bare or weed fallow, in order to determine the effect of peas and clover on the yield of potatoes and their effect in modifying the fertilizer treatment to make it most profitable. For this purpose, every other plot in the series to be planted in 1910 will be seeded this year about July 1 to peas and crimson clover. This plan will be continued, possibly with slight modification, for each succeeding year's potato fertilizer experiments.

3d. Beginning this year and each year thereafter for five years, there will be started a new series of large size crop rotation demonstration plots 1½ acres each in size, using the best fertilizer as indicated by the smaller size fertilizer plots, and employing the very best methods of seeding, cultivation, handling, etc. These 1½ acre plots will be planted ½ acre in early potatoes, ½ acre in tobacco, and ½ acre in late potatoes, and each of these series of plots will be carried through a complete rotation similar to that mentioned above in connection with the tobacco and potato fertilizer plots. This is expected to give valuable data as to the profitableness of tobacco compared both with early and late potatoes, together with their comparative influence on the yield of succeeding crops and their effect in maintaining or building up the fertility of the soil.

The early potatoes will have to be omitted this year, but another standard late variety will be grown instead, which will give data as to their comparative value as yielders.

In connection with these ½-acre plots of potatoes valuable data for Southern Maryland conditions will be obtained as to the effectiveness of spraying for blight by spraying half of each plot and leaving the other half unsprayed.

The 1½-acre plot intended for potatoes and tobacco in 1910 will this year be planted in cowpeas and crimson clover.

4th. Variety tests of potatoes will be conducted each year on small plots, using for comparative purposes about 5 or 6 varieties each of early and late potatoes.

This plan by the 5th year will bring into use about 20 acres of land.

Veterinary Investigations

During the year this department has been engaged principally in the study of the cow's udder.

Externally a comparison by shape, dimensions and general character has been made of all cows in our herd with reference to breeding, age, size and milk production. This comparison revealed the necessity for a more detailed and elaborate scheme for scoring than that provided in the score card for dairy animals. Such a scheme was worked out and used in scoring these udders.

The circulation of blood in the udder was studied, and here too it was found necessary to devise a suitable injecting apparatus. This was perfected in a series of trials with crude appliances, until an outfit of tanks and a pressure pump gave almost ideal results, and in addition to its use for this purpose, is applicable to all forms of vascular injection necessary for anatomical study.

The histology of the udder is deficient in regard to the distribution of lymphatics and the mode of nerve endings. This will require further work and will probably be taken up during the present year.

The test begun several years ago to determine the efficacy of Bovo-vaccine in the suppression of tuberculosis has proceeded far enough to warrant certain conclusions and these are based upon the same conditions as apply to the detection of tuberculosis with tuberculin; viz: In order to secure proper results it is imperative that the most careful and painstaking efforts to comply with the technique of the work be followed and when so carried out it would seem that:

1st. Bovo-vaccine greatly increases the resistance to tuberculosis for at least two years after vaccination is completed.

2d. Tuberculin is practically infallible in the detection of tuberculosis in cows.

3d. Bovo-vaccination and tuberculin injections are not operations of a character that they can be recommended for indiscriminate application by laymen or others not in a position to attend to the details of the work.

4th. That all work of this character and the sale of all such biological products should be under the supervision of proper State authorities.

Leucoencephalitis in horses has been observed in isolated cases but no further light has been thrown upon its cause, prevention or cure.

A compilation of the dairy herd records of our station has apparently shown an important relation between services and abortions, where contagious abortions exist, and if borne out by other records will establish a principle in treatment of this disease of the highest economic importance.

For the ensuing year two lines of work will be pursued, viz:

FAT CELLS

1. A study of the size and properties of fat cells as they exist in milk of the different breeds.
2. The relation of size of fat cells to fat content.
3. The character of the emulson and relation to size of fat cells.
4. The resistance which fat cells have for coalescence.

INFLAMMATION

The determination of the relation of bacteria, leucocytes and chemical changes in milk as affected by inflammation.

The equipment for milk studies needs to be enlarged by the purchase of a laboratory separator, Babcock tester, additional reagents and supplies, and a laboratory microtome.

PUBLICATIONS

The following is a list of the publications issued during the past year:

Bulletin			Pages
129.	Silos and Silage in Maryland; by	Howard L. Crisp H. J. Patterson	1–78
130	Nurseries and Nursery Inspection	T. B. Symons J. B. S. Norton C. P. Close	79–128
131	Treatment for San José Scale; T. B. Symons		129–149
132	Irish Potato Investigations	C. P. Close T. H. White	150–174
133	Cabbage Experiments and Culture by C. P. Close		175–200
134	Flies, Mosquitoes and Brown Tail Moth; T. B. Symons		201–224
135	Butter Making in Maryland; C. W. Melick		225–284
136	Whipped Cream, by C. W. Melick		285–300

FINANCIAL STATEMENT

The following reports of the treasurer show the revenue of the station and the way it was expended the past year:

HATCH FUND

Maryland Agricultural Experiment Station, in account with the United States Appropriation.

Dr.

1909	
To receipts from the Treasurer of the United States as per appropriations for the fiscal year ended June 30, 1909, as per Act of Congress, March 2, 1887	$15,000.00

Cr.

Salaries	$10,831.63
Labor	2,377.56
Publications	188.66
Postage and stationery	150.60
Freight and express	198.99
Heat, light, water and power	297.84
Chemical supplies	15.65
Seeds, plants and sundry supplies	320.42
Library	195.25
Tools, implements and machinery	149.23
Furniture and fixtures	97.00
Live stock	90.51
Buildings and repairs	76.56
Contingent expenses	10.00
Total	$15,000.00

The above is a true copy of the books of this office.

Frank R. Kent,
Treasurer Maryland Agr. Exp. Station.

ADAMS FUND

Maryland Agricultural Experiment Station, in account with the United States Appropriation.

Dr.

1909		
June 30	To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1908, as per Act of Congress, March 16, 1906	$11,000.00

Cr.

1909.		
June 30,	By salaries	$7,686.99
	Labor	252.00
	Postage and stationery	42.12
	Heat, light and water	207.12
	Chemical supplies	325.53
	Seeds, plants and sundry supplies	184.61
	Fertilizers	8.00
	Feeding stuffs	651.05
	Library	299.74
	Tools, implements and machinery	200.83
	Scientific apparatus	551.92
	Furniture and fixtures	112.53
	Live stock	329.75
	Travelling expenses	33.63
	Buildings and repairs	114.18
		$11,000.00

The above is a true copy from the books of this office.

Frank R. Kent,
Treasurer, Maryland Agr. Exp. Station.

STATE FUND

Maryland Agricultural Experiment Station, in account with the State of Maryland Appropriation:

Dr.

Date	Item	Amount
1908		
July 1,	To cash balance	$427.72
	From State	7,500.00
	Interest	7.38
		$7,935.17

Cr.

Date	Item	Amount
1909		
June 30,	By repairs	$991.98
	Publications	1,297.86
	Exhibits	66.12
	Freight and express	470.12
	Feeding experiment	693.61
	Tobacco experiment	691.52
	Poultry experiment	716.91
	Insurance	233.25
	Labor	947.91
	Seeds, plants and sundries	160.15
	Tools, implements, machinery	62.03
	Chemical supplies	4.10
	Travel	278.21
	Salaries	771.31
	Postage and stationery	63.70
	Irrigation and drainage	443.42
	Furniture and fixtures	38.35
	Balance	22.46
		$7,935.17

The above is a true copy from the books of this office.

Frank R. Kent,
Treasurer Maryland Agr. Exp. Station.

HORTICULTURAL FUND

The Maryland Agricultural Experiment Station, in account with the State of Maryland Appropriation for Horticultural Investigation.

Dr.

1908		
July 1,	To cash balance	$2,954.39
	Interest	6.68
		$2,961.07

Cr.

Salaries	$490.00
Seeds, plants and sundry supplies	1,226.64
Travel	163.96
Library	74.06
Labor	136.88
Fertilizer	125.36
Postage and stationery	133.38
Tools, implements and machinery	131.49
Heat, light and water	38.50
Publications	196.86
Freight and express	235.65
Balance	8.29
	$2,961.07

The above is a true copy from the books of this office.

Frank R. Kent,
Treasurer, Maryland Agr. Exp. Station.

STATION FARM FUND

Maryland Agricultural Experiment Station, in account with the Station Farm.

1908	Dr.	
July,	To balance	$11.39
	Sale of stock and produce	4,725.86
	Interest	8.61
		$4,745.86

Cr.

Live stock	$840.00
Fertilizer	459.94
Feed stuffs	651.55
Travel	300.00
Freight and express	335.66
Trustees' expenses	385.00
Seeds, plants and sundry supplies	139.10
Labor	1,577.39
Balance	57.22
	$4,745.86

The above is a true copy from the books of this office.

Frank R. Kent,
Treasurer, Maryland Agr. Exp. Station.

THE MARYLAND
Agricultural Experiment Station

BULLETIN NO. 129 JULY, 1908

SILOS AND SILAGE IN MARYLAND

The Construction of Silos and the Making and Feeding of Silage

BY HOWARD L. CRISP AND H. J. PATTERSON

INTRODUCTION.

While silos and silage have been in use in Maryland for more than 30 years yet there are many questions that arise in the minds of those who are about to adopt this method of preserving and using feed that require more detailed information than is available to most Maryland farmers. The matter in this bulletin has been compiled with an idea of collecting some detailed information from the users of silos and silage in Maryland and putting the results of the experience of these practical farmers within the reach of their brothers and thus encourage if possible the more general use of silage. The use of silage has increased greatly in Maryland during the last few years, but there are thousands of farmers who are feeding dairy and fattening cattle who could profitably adopt the silo.

The matter with reference to the construction of silos, the sketches, photographs, estimates of materials, etc., were made by Mr. Howard L. Crisp, assistant in the Mechanical Engineering Department of the Maryland Agricultural College. The matter giving information as to making and feeding silage, and the preparation of all the material for publication has been done by H. J. Patterson.

DEFINITIONS.

As there is still much confusion in the terms used by speakers and writers in connection with this subject it may not be out of place to give here the more generally accepted and modern meanings of the terms used. The word *Silo* signifies any air-tight structure used for the preservation of forage in a succulent condition. The feed taken out of the silo is *Silage* (formerly and originally called *ensilage*). The process of putting feed into the silo is frequently designated by the words, *to silo, ensilaged* and *ensiloing;* but more generally spoken of as *making or cutting silage.* The farmer who makes and uses silage is sometimes called a *siloist.* The particular kind of silage is designated by prefixing the name of the crop used for making it, as Corn silage, Clover silage, Cowpea silage, etc.

HISTORY.

The history of silage dates back to antiquity; but it was not until 1875 that it attracted much attention or that it can be said to have been introduced into modern agriculture. In 1875 Auguste Goffart, of France, announced the results of his experiments, which had covered several years, with preserving green forage; and for the successful outcome of which he was awarded by his government (in the same year) the Cross of the Legion of Honor.

The first silage made in America was prepared by Francis Morris, of Ellicott City, Maryland, in 1876, by putting whole corn in a trench or pit dug in the ground and covered with earth. He reported that he found it fairly well preserved and that stock ate it well. The first silo was built by Dr. J. M. Bailey, of Boston, Massachusetts, the successful opening of which was reported in "The Country Gentleman" in December, 1879. This report, together with Dr. Bailey's "Book of Ensilage" published in 1880, brought the subject of silos and silage prominently before the farmers of the United States and resulted in many adopting this method of preserving feed and becoming enthusiastic advocates of the practice. From this beginning the use of the silo has spread rapidly until today there are few dairy sections where silos are not common and in general use.

ADVANTAGES OF SILOS AND SILAGE.

The advantages which are obtained through the use of a silo for preserving coarse fodders for the feeding of farm animals may not be the same for each individual case; but the points enumerated herewith will probably hold in the majority of instances and cover average conditions.

1. The product of an acre of land can be stored in less space by making it into silage than by curing in any other way. Hay placed in

the mow will take up about three times the space and corn fodder about five times the space as the same quantity of food materials placed in the silo.

2. An acre of corn can be placed in the silo at less cost than the same quantity can be put up as cured fodder. The usual method of cutting and shocking the crop, then husking, cribbing, shelling, grinding the grain, storing and shredding the fodder and then putting them together again is expensive and would seem to require much labor that might be obviated if the whole crop was secured at one time as is done in putting it in the silo. The storage of the corn crop in the silo makes it possible to clear the ground completely and earlier, and thus facilitates the preparation of the land for seeding grass and fall grains.

3. The use of a silo makes it possible to use smaller buildings thus reducing, the cost of plant, the interest on investment, the cost of repairs and insurance and the risk from fire.

4. The use of the silo makes it possible to preserve roughage so as to entail a minimum of loss of food and feeding value. Tests have shown that the loss through the breaking off of leaves and tender parts and through the fermentation changes in curing fodder in ordinary farm practice amounts to 10 to 25 per cent, while the loss in the crop if put into a silo is only about 10 per cent and by following the practice of many dairymen of beginning to feed from the silo as soon as it has been filled the loss can be reduced to a minimum and should not be over 5 per cent.

5. Crops can be secured in the silo during weather that could not be availed of to make hay or cure fodder.

6. More cattle can be kept on a given area of land when silage is fed than when the roughage is cured for hay or fodder, or when the land is used for pasture purposes.

7. Crops unfit for making hay will often make a nutritious, palatable silage and thus enable the farmer to carry his stock during times when hay crops are a failure.

8. The use of silage enables the feeding of a succulent and uniform food the entire year. Silage is beneficial to digestion and general health of animals. It is a mild laxative and keeps the digestive system about in the same condition as when animals are on pasture or being fed with green fodders. The feeding of silage previous to turning animals out to pasture is beneficial and prevents the loss in weight which frequently occurs.

9. Silage is valuable for supplementing the pastures at such times

as they are short and thus preventing animals from losing flesh or falling off in their flow of milk.

10. The use of silage enables animals to be fed more economically than by the use of dry roughage and usually yields a better quality and greater quantity of product. This is true both in the production of meat and milk.

GENERAL OBSERVATIONS AND SUGGESTIONS ON SILO CONSTRUCTION.

Before giving details as to the construction of particular silos it may be well to give a few of the fundamental principles which have been determined, so as to enable a person constructing a silo to include the essential features and avoid serious mistakes, no matter what type may be built.

It is highly important to build a thoroughly good silo. That is a silo that will keep the silage in good condition and reduce the loss of feed to a minimum. Each ton of silage which spoils represents the interest on about twenty dollars, consequently it requires but little calculation to determine that it will pay to spend enough to make a silo that will keep the silage. In constructing a one-hundred-ton silo do not build a cheap and imperfect structure, but spend $100.00 to $150.00 more and construct a silo that will keep the silage, rather than one that will allow 10 to 20 tons of silage to spoil each year.

The following points should be observed as closely as possible:

1. Make the bottom and sides of the silo air tight. Much silage spoils because of air getting in at the bottom or at the sides or around the doors. The silo should be either tight all the time or in such a condition that the damp silage will cause it to swell tight in a few hours after filling.

2. The silo must be relatively deep. Depth is essential in order that the siloed fodder will pack well and develop considerable pressure and thus exclude the air as completely as possible. A silo should be two to three times as deep as the diameter.

3. The silo should have smooth perpendicular walls so as to facilitate the packing and even settling of the siloed fodder.

4. Have as few corners as possible so as to facilitate thorough packing. Corners are difficult to pack and are generally the place where most loss occurs.

5. The floor should be firm, smooth, air tight and rat proof, and give good drainage. They may be made of stiff clay or concrete.

6. The foundation should be substantial, strong, and extend below frost line, and when a wood superstructure is used the foundation should be at least 18 to 24 inches above the surface of ground so as to keep dampness and decay from the ends of the boards or sills. The sills, or with stave silos, the ends of the staves should be treated with some preservative and bedded in tar and cement so as to exclude the air. The foundation of a silo should be even more carefully constructed than that of a house.

7. A roof is not absolutely essential on a silo but, all things considered, will generally be found desirable. There should be some ventilation provided in the roof so as to allow the escape of dampness and gases which develop in the fermentation of the silage.

8. There are a great many styles of doors all of which may possess some special advantage over others. Most persons favor some kind of a continuous door from top to bottom rather than the style with doors at intervals. In all cases the door should be made so as to be tight and not admit air. This is a weak point with many silos and much silage spoils on account of leaks around the door.

THE CAPACITY OF THE SILO.

The size of the silo to be built should be determined by the amount of stock to be fed and the length of the silage feeding season. In most parts of Maryland it will usually be found desirable to have silage available from six to seven months, and in sections where summer pastures are limited or subject to being cut short by dry weather it is well to provide for supplementing the pasture, particularly up to the middle of July or the period when soiling crops can be depended upon.

Silage is usually fed to cows and steers at the rate of 30 to 40 pounds per day. This would mean that in 200 days a cow would require from 3 to 4 tons of silage. These figures give a safe basis for calculating the requirements of a herd.

The size of the silo should be such as to make it possible to feed daily from the whole surface of the silo to a depth of two inches; so as to prevent loss by undue exposure of the silage to the atmosphere and keep it in the best condition for feeding.

Silage weighs from 30 to 50 pounds per cubic foot. Good corn silage averages about 35 to 40 pounds. Clover and cowpeas silage weigh more than corn silage. One acre of corn should yield from 10 to 15 tons of silage and one acre of clover, vetch, cowpeas, rye, etc., should yield form 8 to 10 tons of silage.

APPROXIMATE CAPACITY OF CIRCULAR SILOS, IN TONS.

(Estimated on the basis of silage made from well matured corn.)

Height of Silo.	INSIDE DIAMETER OF SILO—FEET.						
	10′	12′	14′	15′	16′	18′	20′
feet.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
20	26	38	51	59	67	85	105
21	28	40	55	63	72	91	112
22	30	43	59	67	77	97	120
23	32	46	62	72	82	103	128
24	34	49	66	76	87	110	135
25	36	52	70	81	90	116	143
26	38	55	74	85	97	123	152
27	40	58	78	90	103	130	160
28	42	61	83	95	108	137	169
29	45	64	88	100	114	144	178
30	47	68	93	105	119	151	187
31	49	70	96	110	125	158	195
32	51	73	101	115	131	166	205

In calculating the capacity of rectangular silos, forty pounds may be taken as the average weight of one cubic foot of corn silage. One ton of silage will accordingly take up 50 cubic feet; and 100 tons, 5000 cubic feet. If a rectangular one-hundred-ton silo is to be built it may be 12 x 14 feet and 30 feet high. or 12 x 12 x 35 feet, or 13 x 13 x 30 feet.

From the above figures a farmer may plan his silo and the area of silage crops to meet his requirements.

SILAGE CROPS.

The crops most available for making silage in Maryland are corn, sorghum, cowpeas, soja beans, winter vetch, clover, wheat, rye, oats and millets. These may be grown and used either separately or in various combinations.

All silage crops should be harvested when they are fairly well matured. Corn is in the best condition for the silo when the kernels are nicely glazed or in about the same condition that it would be cut for saving the grain. Other forage crops should be cut for silage when in about the proper stage or best condition for making hay.

Corn from the ease with which it can be grown and converted into silage is entitled in most places to head the list of forage crops for this purpose. Corn is adapted to a wide range of soils and conditions and will usually produce more silage per acre than any crop that can be grown.

Corn will usually yield from 10 to 15 tons per acre, and larger amounts are frequently reported even up to 30 to 40 tons.

In selecting a variety of corn for silage always use one that will mature its grain as such strains will make the best of silage. Other things being equal, varieties that produce a large fodder will be found most desirable. The Cocky's Prolific and Hickory King types of corn are very good as they give a high yield and produce three or four small ears per stalk instead of one large ear and consequently they are easier on the cutting machinery.

Silage corn can be planted a little thicker than is ordinarily used in growing grain, but it should not be planted so thick as to prevent a good ear development. The thickness will depend upon the soil and the varieties used.

Corn and Cowpeas: This combination has proven very good at this Station and in many places where tried. The practice here is to plant the corn and the cowpeas at the same time using a planter with two hoppers for this purpose. The spouts from the hoppers are arranged so that the peas and corn are dropped in the same hill. The quantity of seed used can be regulated by the plates, but usually it is found best to have one plant of each at a place.

The variety of peas for this purpose will probably vary with location. The ones which have proven best from the results of experiments at this Station are the Wonderful, the Red Ripper and the Whip-poor-will cowpeas and the Virginia Cornfield bean. The variety of peas should be selected so that both corn and peas are in condition for putting into the silo at the same time. Many of the peas mature too early for satisfactory results.

The results at this Station have shown that the growing of corn and cowpeas in combination increases the yield of corn, that is, there was more corn on the plats that had peas than on those that had none. The average advantage has been in increasing the yield of silage about three tons per acre and in improving the quality 25%. The land was also left in better condition.

Sorghum is a fairly good crop for silage though usually not as easily grown as corn, except on very dry soils. The hard covering of the stalk makes it more or less unpalatable to stock. The saccharin varieties of sorghum make a more acid silage than corn. Cowpeas can be grown in combination with sorghum the same as corn. Sorghum and cowpeas grow satisfactorily when sown broadcast.

Cowpeas and soja beans both make good crops to grow for winter silage. They may be put into the silo by themselves or mixed with corn. They make a good quality of silage which cattle soon learn to like and do well on. Cowpea and soja bean silage does not become as acid as corn silage and they will weigh more per cubic foot. They yield from 6 to 10 tons of silage per acre.

For summer silage crimson clover, red clover, winter vetch, rye, wheat, and vetch and wheat, or vetch and winter oats, grown in combination are very satisfactory crops. They will yield from 6 to 12 tons of silage per acre.

METHODS OF HANDLING SILAGE CROPS.

The harvesting of corn and sorghum for the silo may be done by hand with the ordinary corn knife, but the corn harvester or binder will be found a valuable implement for this work. The corn binder not only facilitates the cutting of the crop in the field; but having the corn tied in bundles makes the loading of it on the wagon and feeding it into the fodder cutter much easier and quicker.

In harvesting the finer growing forage crops, the mower and rake will answer all purposes. Great care should be taken to avoid raking up stones and other foreign bodies which might injure the fodder cutter.

For hauling silage crops the use of wagons with low wheels have many advantages but when this kind of wagon is not available building up a platform on the regular wagons which will throw the load above the wheels and standards will be found to facilitate the unloading after the manner shown in fig. 1.

FILLING THE SILO.

For best results forage which is put into a silo should be cut fairly fine so that it will pack close and exclude the air as much as possible. This material can be conveyed into the silo by means of an elevator or conveyor. There are a few favored sections that can locate the silo so that it may be filled from the cutter by gravity. The silo may be filled with uncut forage, but this is not advisable if cutting machinery can be procured, as the silo will not hold as much and the material in its natural shape will not pack tight enough to keep as well as when cut. If the amount of silage to be put up will not warrant a farmer in owning a cutting outfit they can usually be hired in most neighborhoods upon about the same basis as a threshing machine.

The silo may be filled all at once or gradually from day to day as may suit the owner's convenience.

In slow filling the work should be done at least rapidly enough to prevent any mold from forming at the surface. In rapid filling a day or so must be allowed for settling and the silo filled up a second or third time so as to utilize all the space.

In all cases it is important to have the forage packed into the silo as tight as possible. Tramp it very thoroughly around the edges.

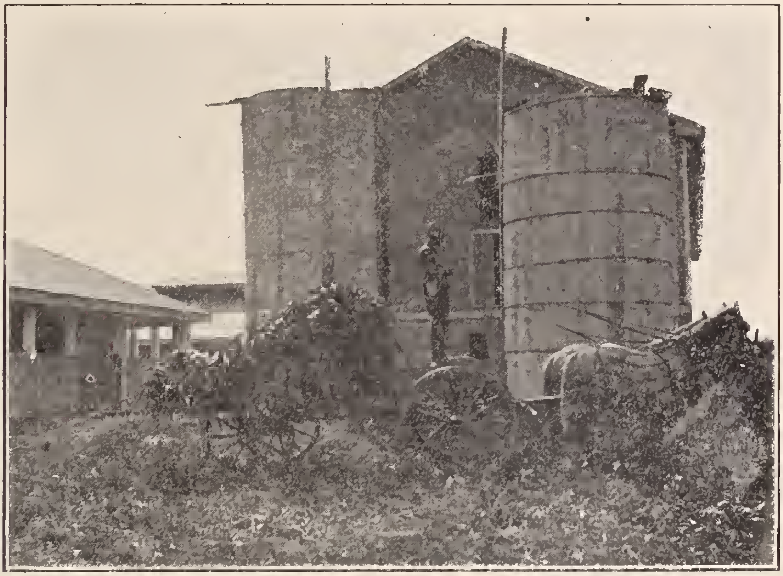


Fig. 1. Showing a method for unloading fodder at silage cutter. Note the double rope which is placed on the bottom of the wagon and passes over the top of the load which can be hooked into a chain fastened to a short post in the ground. The team moving on pulls the load off.

After the silo is full and nothing more is to be put in, wet the top at the rate of about one gallon per square foot and then tramp it down thoroughly. This causes a compact decomposed mass to form on the top which effectually excludes the air and reduces the amount of spoiled silage to a minimum.

A plan pursued by many farmers which works very well is to give a heavy sprinkling of oats, wheat or rye over the top of the silage before wetting. This grain sprouts and forms a very dense growth of roots with a thin layer of decomposed material which affords a good protective covering for the silage and allows very little to spoil.

The practice of many to keep silage from spoiling is to begin feeding it at once, using only a very thin layer each day or just enough to prevent its spoiling.

POISONOUS GAS IN THE SILO.

The top of the silo should be ventilated, and if there is much space between the top of the silage and the top of the silo, or between the bottom of the silo and the lower door, without ventilation, care should be taken in going into the silo as there may be enough carbon dioxide gas formed to cause suffocation. This can be tested by lowering a lantern to the bottom of the empty space. If the light continues to burn it will be safe to enter, if it goes out dangerous. If the silo should be found to contain an injurious amount of carbon dioxide it can be removed by agitating the air with a bundle of hay or the branch of a tree lowered into the silo with a rope.

FEEDING SILAGE.

When judiciously used silage can be fed with advantage to all classes of farm animals.

Silage should not be fed as an exclusive coarse feed. but always in connection with some dry roughage. The nearer the maturity the forage is cut for the silo, the more silage may safely be fed, but it is always well to avoid feeding it excessively.

The difference in the chemical composition and digestibility of the same forage green, dried, and in the form of silage, is very slight and the relative feeding value of the different forms is dependent chiefly upon their palatability and physical effect. Silage is usually more palatable to animals than dry feeds and it acts as a mild laxative and keeps the digestive system in better condition than is usual with most dry feeds. Silage, green soiling feeds, and pastures seem to keep the digestive system in about the same condition. Silage furnishes that succulency in a ration that seems necessary for stock to do their best work.

Some years ago the writer of this Bulletin conducted an extensive set of digestion experiments in comparing silage and corn fodder (4th Annual Report, 1891) in summing up the results of which the following statement was made:

We see there is but little difference between the digestibility of the silage and the fodder rations, the slight difference which occurs being in favor of the silage. But we must not overlook or forget the fact that this slight difference is in all probability due to the difference in methods of growing the fodder and not to any extent to be attributed to the ensiling. Corn stover (fodder) has been found to differ but slightly in digestibility from corn fodder or corn silage. The digestibility of the crude protein is very nearly the same in each, that of the silage being slightly the higher. The fat in the silage is also more digestible, but this may be due almost entirely to the amount of acid which the silage contains.

COMPOSITION OF SILAGE.

From the table given below it will be noted that most of the silages are relatively low in protein, and this is particularly true of the corn silages. In order to supplement this the farmer should aim to grow the protein feeds like clover, alfalfa, peas, and vetches, to as large an extent as practicable and thus be able to feed a balanced ration without purchasing the expensive by-product protein feeds. The composition of the silage will vary with the maturity of the forage crop used.

TABLE SHOWING THE COMPOSITION OF VARIOUS SILAGE CROPS.

In pounds per hundred (per cents).

	Water.	Ash.	Crude Protein.	Crude Fiber.	Nitrogen Free Extract.	Fat.
Corn silage—mature corn	73.7	1.6	2.2	6.5	15.1	0.9
Corn silage—immature corn	79.1	1.4	1.7	6.0	11.0	0.8
Corn silage—ears removed	80.7	1.8	1.8	5.6	9.5	0.6
Clover silage	72.0	2.6	4.2	4.8	11.6	1.2
Soja bean silage	74.2	2.8	4.1	9.7	6.9	2.2
Cowpea vine silage	79.3	2.9	2.7	6.0	7.6	1.5
Canada pea vine silage	50.0	3.6	5.9	13.0	26.0	1.6
Corn cannery refuse—husks*	83.8	0.6	1.4	5.2	2.9	1.1
Corn cannery refuse—cobs*	74.1	0.5	1.5	7.9	14.3	1.7
Pea cannery refuse*	76.8	1.3	2.8	6.5	11.3	1.3
Sorghum silage	76.1	1.1	0.8	6.4	15.3	0.3
Corn-soja bean silage	76.0	2.4	2.5	7.2	11.1	6.8
Millet-soja bean silage	79.0	2.8	2.8	7.2	7.2	1.0
Cowpea-soja bean silage	69.8	4.3	3.8	9.5	11.1	1.3
Rye silage	80.8	1.6	2.4	5.8	9.2	0.3
Apple pomace silage	85.0	0.6	1.2	3.3	8.8	1.1
Brewers Grains silage	69.8	1.2	6.6	4.7	15.6	2.1

*=Analyses made at the Maryland Experiment Station from samples procured of B. F. Shriver & Bro., Union Mills, Carroll Co., Maryland.

SILAGE FOR COWS.

Silage is more used in rations for dairy cows than for any other class of animals. In fact it has been prominent in bringing about the present development of the dairy industry and enabling the maximum production at the minimum cost. Silage is well liked by cows and they thrive on it, make liberal yields and maintain good health. Since silage is relatively rich in carbohydrates and low in protein, clover hay, cowpea hay, and alfalfa hay are all good as a supplementary roughage. From thirty to fifty pounds is the usual daily allowance of silage for a cow.

SILAGE FOR STEERS.

The progressive feeder of beef cattle will find that silage is just as important in the economical production of flesh and fat as the dairyman does in the economical production of milk. Corn silage will furnish a cheap succulent winter feed for cattle that will keep the system cool and the appetite vigorous. The quality of silage fed beef is better than on dry roughage. In the early stages of feeding a 1000-pound steer can be fed 40 to 50 pounds of silage and then reduced to about one-half that amount when on a full grain ration and towards the end of the feeding period.

SILAGE FOR SHEEP.

Silage is looked upon with great favor among sheep men. Succulent food is imperative for successful sheep raising, and this is particularly true in raising fine early lambs. Silage on most farms will furnish this succulency cheaper than root crops. Silage is inclined to be fattening and should be fed in limited quantities to breeding ewes. Silage fed ewes give strong vigorous lambs and drop them without trouble. Ewes should be fed from 2 to 4 pounds of silage per day per head. Fattening sheep may be fed double these amounts.

SILAGE FOR HOGS.

Hogs do not like silage and they will not eat much of it so that it is of little economic importance in feeding them. This Station has fed corn and cowpea silage to hogs but it was eaten in such small quantities as to have practically no effect on the ration. Some few reports have been made through the agricultural press of great success in feeding clover silage to hogs, but tests at the Wisconsin Station have not been satisfactory.

SILAGE FOR HORSES AND MULES.

Silage is too bulky to be considered an ideal feed for horses or mules which are at work, though it has been fed in limited quantities in numerous cases with success. A little of it acts as a mild laxative and will keep the digestive system in good condition. Silage fed horses keep in good condition and look well. Silage should be fed to horses in small quantities at first. Some horses object to silage at first but usually they soon learn to like it. Brood-mares and idle horses may be fed larger quantities than work horses, but in neither case should the quantity be large or form the entire roughage portion of the ration but it should be supplemented with some hay or straw.

DESCRIPTION AND NOTES TAKEN ON MARYLAND SILOS.

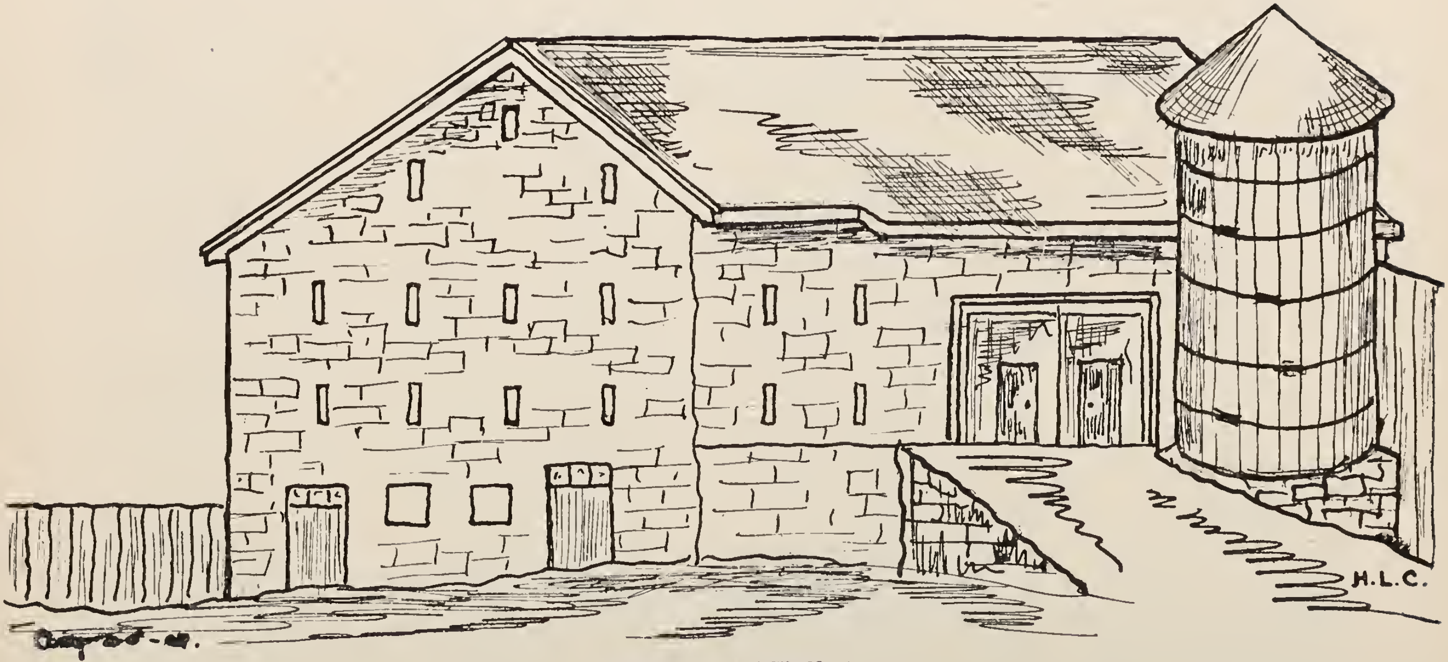
Mr. H. L. Crisp visited during the summer of 1907 about eighty farms in different parts of Maryland and took pictures, made sketches and collected a miscellaneous lot of data that may be helpful to those who contemplate the construction of a silo. This data has been compiled in the notes given on the following pages.

The notes are numbered in the order in which the farms were visited. The pictures, sketches cross-section, etc., are numbered to correspond to the respective note. In giving the dimension of silos the height is always given last. In round silos the first dimension given is the diameter. The capacity given is that claimed by the owner which does not always agree with the estimated amount given in the table on page 6. This discrepancy will account for the variation in yields frequently reported.

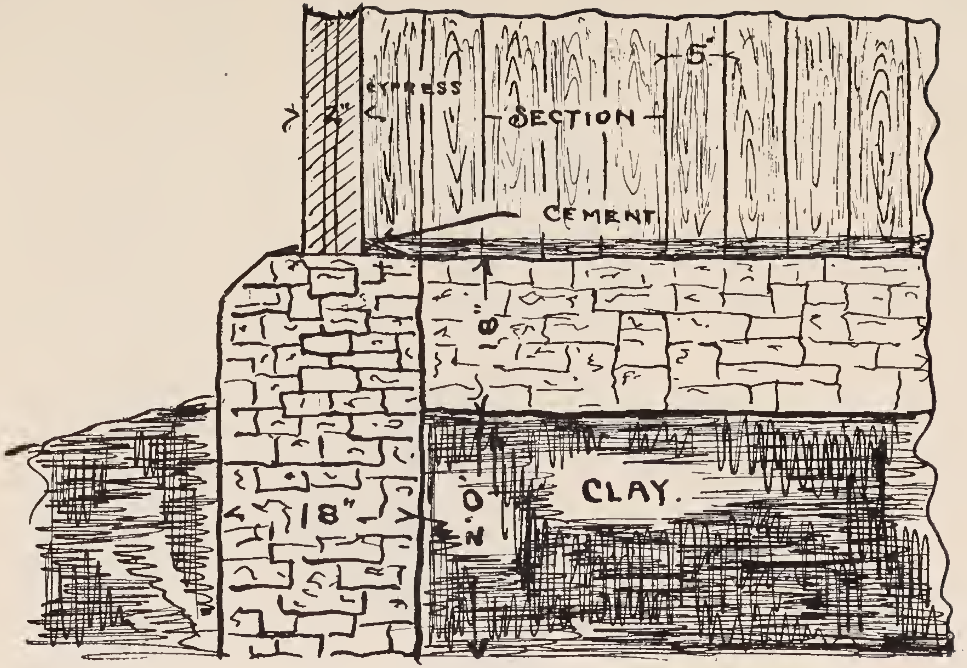
1. Silo on the farm of Mr. Reuben Sayler, Union Bridge, Carroll Co. Purchased round silo, 14′x29′ = 100 tons, requires 7 acres to fill, feeds 8 head cattle. Cypress wood, tongued and grooved. Constructed in two sections with 6-inch iron band at joint. This is not air tight and silage spoils at that point. See sketch No. 1 and cross section No. 1.

2. Silos of Mr. Samuel Diehl, Union Bridge, Carroll Co. Kalamazoo round silos, 10′ x 30′ = 43 tons, cost $100, and 12′ x 30′ = 67 tons, cost $120. Feeds 25 head cattle. Stone foundation 2 feet below ground and 6 inches above ground (see sketch No. 2) required 5 and 6 perches stone. 2″ x 6″ cypress wood, tongued and grooved. Painted with gas tar on inside, not considered advisable. Age of silo 5 years.

3. Silo of Mr. Louis Messler, Union Bridge, Carroll Co. Smith and Reifsnider round silo 14′ x 30′, cost $135. Feeds 15 head cattle. Staves,

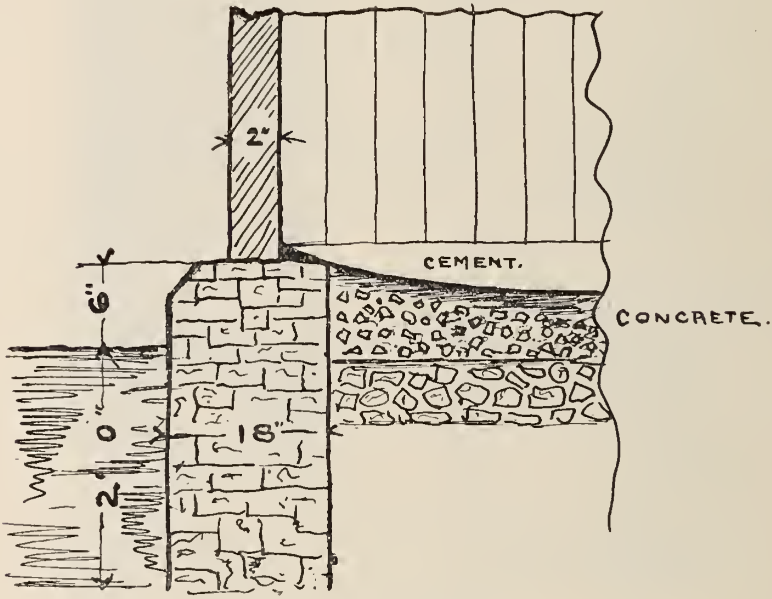


Sketch of Barn and Silo No. 1.



Foundation Construction of Silo No. 1.

cypress wood, tongue and grooved. Stone foundation (10 perch) 2′ 6″ in ground, 12′ above ground. Cost to fill $60 to $75. Outside of silo painted—age 5 years. Uses white field corn for silage. Foundation same as No. 2. Mr. Messler, considers silage unprofitable for cows and has discontinued its use and sold the silo. The iron splices in the staves of the silo had rusted out and the ends of the staves decayed when torn down.

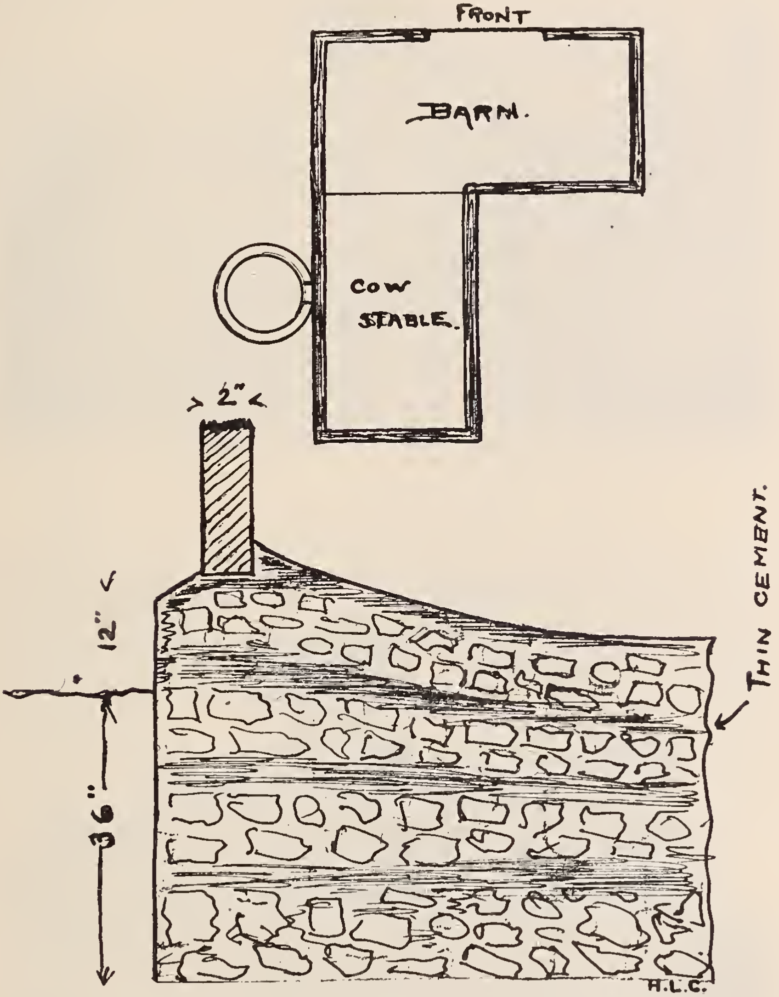


Foundation Construction of Silo No. 2.

4. Silo of Mr. Thaddeus Starr, Union Bridge, Carroll Co. Economy (Frederick) round silo, 14′ x 24′ = 75 tons, cost about $200. Feeds 20 head cattle. Staves 2″ x 6″ white pine wood, tongue and grooved—concrete foundation 2 feet in ground, 1 foot above. Given a coat of red paint on outside each year—age three years. Grows white field corn and requires 6 acres to fill. This is a well-constructed silo, no leaks between foundation and staves, giving good satisfaction. See sketch No. 4. Note style of roof and method of tying silo to barn in photograph No. 4.

5. Silo of Mr. John Stultz, Union Bridge, Carroll Co. Home-made combination, stone and stave, 11′ x 22′ = 35 tons, cost $60. Feeds 10 head cattle. Staves, rough hemlock, 2″ x 6″—20′ (66 staves = 1320

ft). Foundation 2 feet below ground, 18 inches above (6 perch stone). Grows white field corn and requires 3½ acres to fill. Age 1 year. This silo was economical to build, the 2 x 6 rough hemlock was purchased of



Showing Foundation Construction and Location of Silo No. 4.

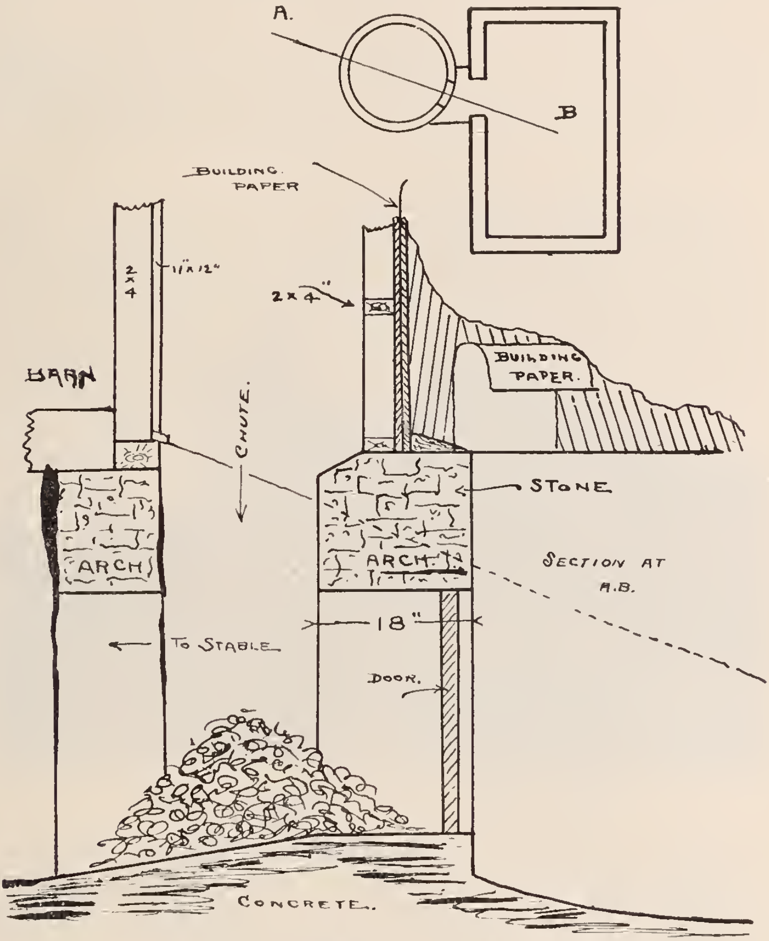
the local lumber yard. Hoops of ⅝″ iron were bent by the tire bender at the smith shop, and hoop lugs were purchased from the Chicago House Recking Co. There are a number of this kind of silos in the neighbor-

No. 4. Silo of Thaddeus Starr, Union Bridge, Carroll Co.

No. 6. Silo of Thos. J. Haines, New Windsor, Carroll Co.

hood of New Windsor and they are reported to preserve silage perfectly. For foundation see sketch No. 2, and for door see sketch No. 6.

6. Silo of Mr. Thos. J. Haines, New Windsor, Carroll Co. Home-made round silo. Combination of stone 6 feet and frame 22 feet. Size



Showing Some Details in the Construction of Silo No. 6.

12′ x 30′ = capacity 75 tons, cost about $200. Construction—stone foundation 18″ thick, 7 feet below ground and 1 foot above (19 perches). Wood frame of 2″ x 6″ Virginia pine with iron hoops, lined with two thickness of $\frac{7}{8}$″ x 2″ Virginia pine flooring put on spirally. The spiral of each layer running in the opposite direction. Building paper between the layers of flooring. For details of construction see photograph No. 6 and sketch No. 6. Painted red on outside. Required 4 men two weeks to build. The only silo of this construction found. The owner would not build another frame like this one. Uses Cuban Giant white silage corn and requires 5 to 6 acres to fill the silo. In use 4 years.

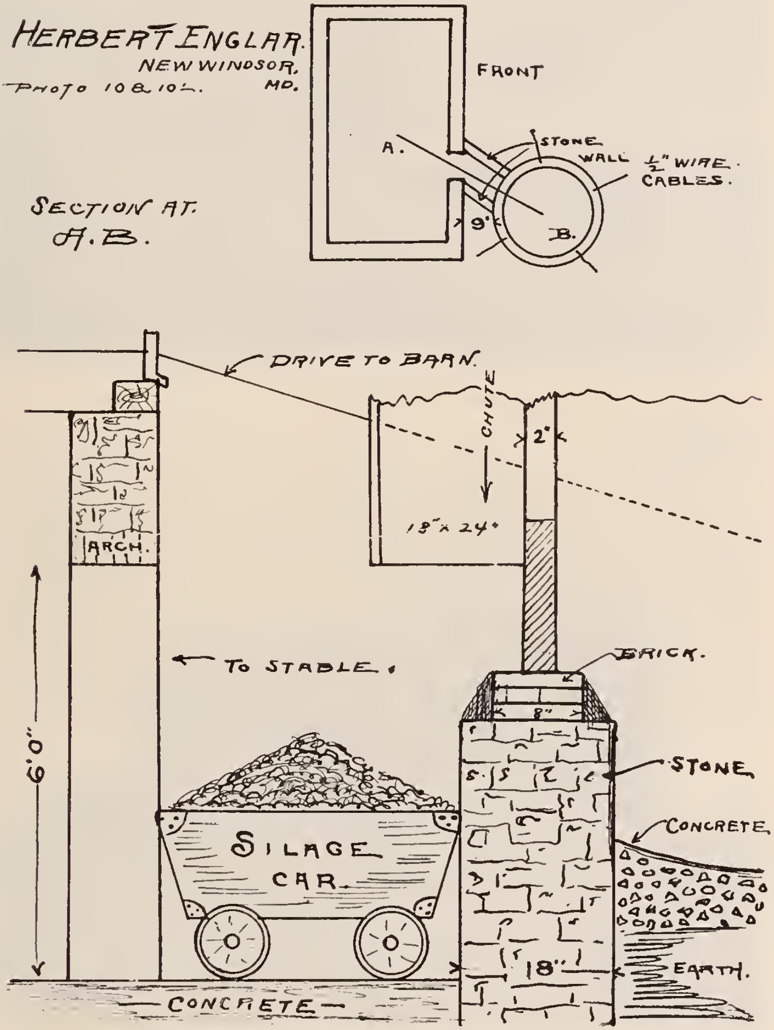
7. Silo of Mr. Herbert Engler, New Windsor, Carroll Co. Economy (Frederick) silo 14′ x 38′, with 2 ft. space in foundation giving a total depth of 40 ft. = 125 tons. Foundation 2 feet below and 2 feet above ground, required 11 perches stone. Staves 2″ x 5″. Painted red on outside. See photograph and sketch.

No. 7. Silo of Herbert Englar, New Windsor, Carroll Co.

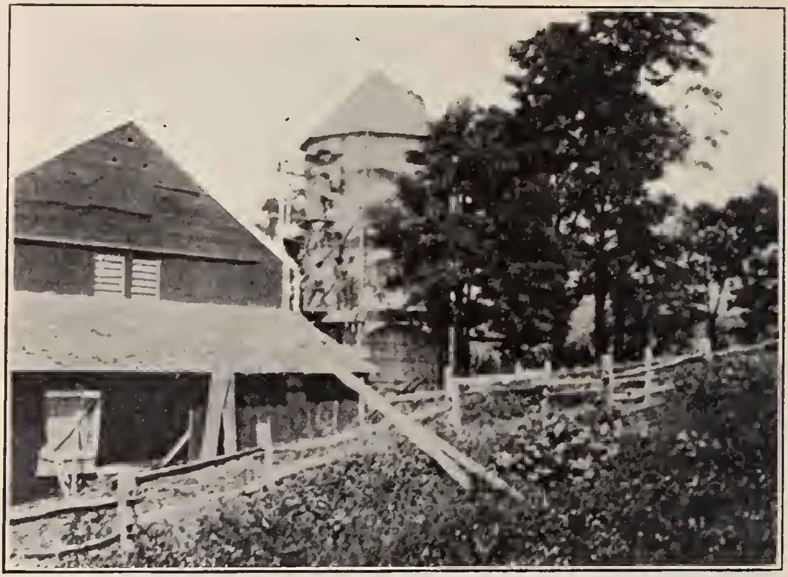
8. Silo of Mr. Wm. Hesson, New Windsor, Carroll Co. "Economy" silo. Combination stave and stone. Frame 16′ x 30′, cost $308. Masonry (stone 25 perches) 16′ x 8′, cost $75. Total 16′ x 38′ = 160 tons, cost $383. Uses white field corn. Feeds 20 head cattle. 1 year old. Chute 18″ x 24″. Contains door and window. See silo in course of construction, photograph No. 8. For details of construction see sketch No. 7.

9. Silo of Joseph Engels, New Windsor, Carroll Co. Home-made combination stone and stave silo, 16′ x 27′ = 105 tons. Cost $85. Feeds 18 head stock—requires 5 or 6 acres to fill. Material required, 22

perches stone—96 staves 2″ x 6″, 20 feet long, or 1920 feet, ⅝″ round iron hoops. Staves beveled on saw. Uses doors made of 1″ x 12″ white pine as it swells tight easily. Uses tar paper over doors. Shed roof hinged. Requires 15 to 18 men to fill in one day. Silo in use 7 years. See photograph and sketch No. 9.

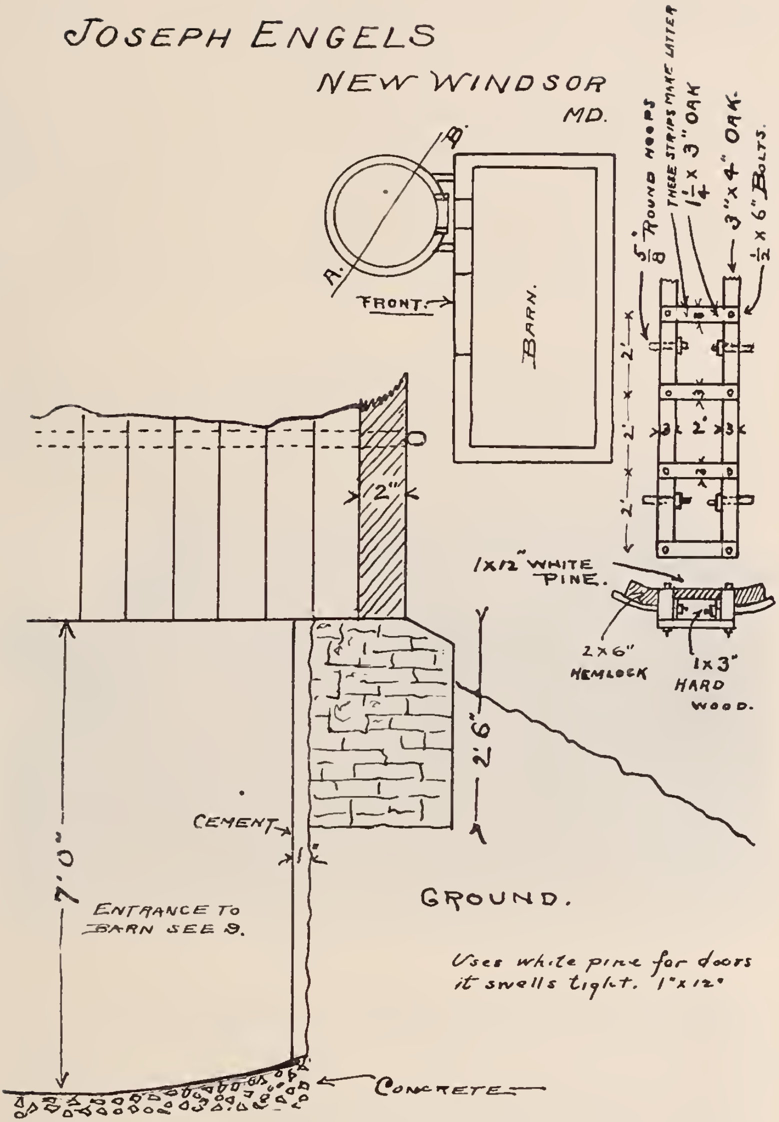


Showing Some Details in the Construction of Silo No. 7.



No. 8. Silo of Wm. Hesson, New Windsor, Carroll Co.

No. 9. Silo of Joseph Engels, New Windsor, Carroll Co.



Showing Details of the Construction of Silo No. 9.

10. Silo on farm No. 1 of H. H. Devilbiss, New Windsor, Carroll Co. Smith and Reifsnider stave silo, 12′ x 30′ = 70 tons, cost $174. Foundation stone, 2 feet below and 1 foot above ground, required 12 perches. See sketch No. 2 for style of foundation.

11. Silo on farm No. 2 of H. H. Devilbiss, New Windsor, Carroll Co. Home-made combination stone and stave, 14′ x 30′ =92 tons, cost $87. Foundation stone (27 perches), 9 feet below and 1 foot above ground. 84 staves, 2″ x 6″, 20 feet long, rough hemlock beveled (total 1680 ft.) ½″ dowels used, placed 3 feet apart. Wood not painted. Feeds 18 head cattle, requires 6 to 7 acres to fill, uses regular field corn. Silo in use 4 years. This silo has proved just as satisfactory as the one on farm No. 1. See sketch No. 6 for foundation and photograph No. 11.

No. 11. Silo of H. H. Devilbiss, New Windsor, Carroll Co.

12. Silo on farm of Mr. C. Carlisle, New Windsor, Carroll Co. Home-made combination silo, 14′ x 30′ = 92 tons, cost $90. In use 3 years, requires 7 acres to fill same as silo 11. Silo 9, 11, 12 which are of practically same construction have proven very satisfactory to their owners.

13. Silo of Daniel Englar, New Windsor, Carroll Co. Home-made combination silo, 12′ x 29′, cost $85. Foundation brick (3500) 6 inches above and 8 feet 6 inches below ground. 73 staves 2″ x 6″, 20 feet rough

hemlock (1460 ft.). Painted red annually. Silo in use 4 years. Feeds 10 head cattle. Silo keeps silage well, very ripe corn makes best silage. Uses tar paper around doors.

14. Silo of Mr. A. P. Snader, New Windsor, Carroll Co. Home-made combination 12′ x 25′. Foundation stone (12 perches) 1 foot above and 4½ feet below ground. 73 staves, 2″ x 6″, 20 ft. rough hemlock, beveled. Used dowel pine. Requires 7 acres of corn to fill—keeps silage very well. Silo in use 6 years and is in good state of preservation.

15. Silo on farm of Louis Green, New Windsor, Carroll Co. All data same as No. 12. Except foundation extends 3 feet above ground and the value of this is noticeable in the ends of the staves being very well preserved.

16. Silos on farm of Mr. Solomon Ecker, New Windsor, Carroll Co. 2 rectangular, 12′ x 20′ x 29′ silos. Depth of frame 14 feet, depth of stone 15 feet. Material used 60 perches stone, 50 pieces 2″ x 4″ x 14′ studding, 4 corner posts, 6″ x 6″ x 14′, 1000 feet 1″ x 12″ and 3000 feet 1″ x 6″. Height of foundation above ground 3 feet. Woodwork whitewashed. Silo in use 22 years, well preserved. Feeds 50 head cattle. See sketch.

This combination silo is on the farm of the late Solomon Ecker. It is said to have been built in 1885, constructed of stone and wood. Originally it was 12′ x 20′ with square corners. The silage spoiled in the corners and the surface was too large, so the silo was divided into two, as shown on the plan. A frame was constructed giving round corners with a radius of two feet. This allowed a hiding place for rats which destroyed these corners.

These combination silos preserve the silage better below the woodwork. This is due to the joint between the stone work and woodwork not being air tight.

The silage is removed from one, then passed from the other into the empty one and from it to the stable.

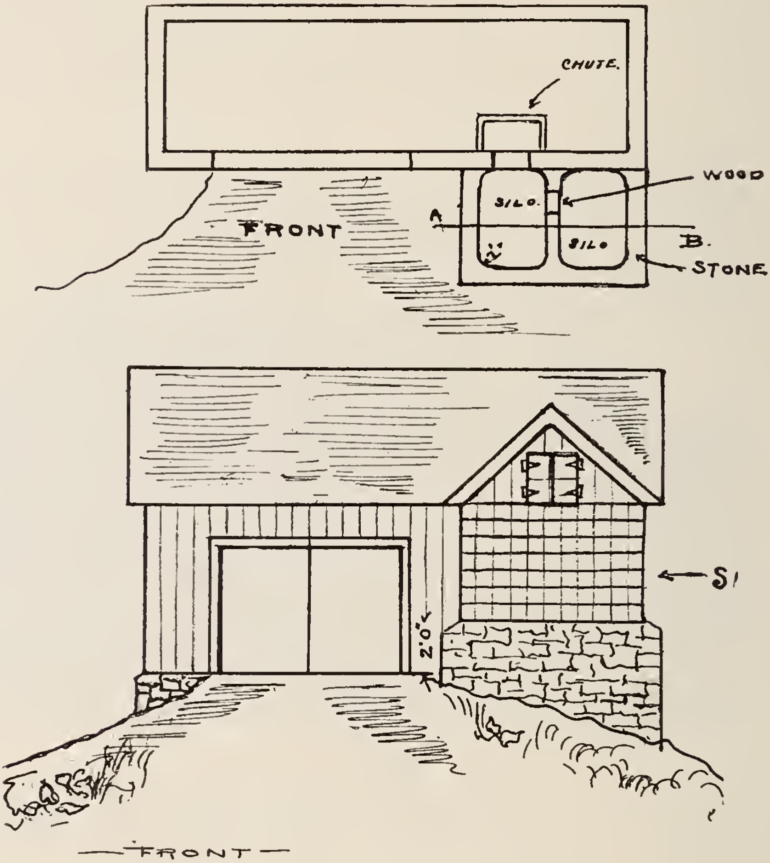
This silo is in good state of preservation, although it is 22 years old. Dampness causes cement to drop off and the stone work has to be patched occasionally.

Eight feet of silage remained at end of season, 6 inches was removed and refilled. This silage was good when used the latter part of the following year.

This was the second silo erected in this section, Elsworth Ecker, his brother, erected the first one.

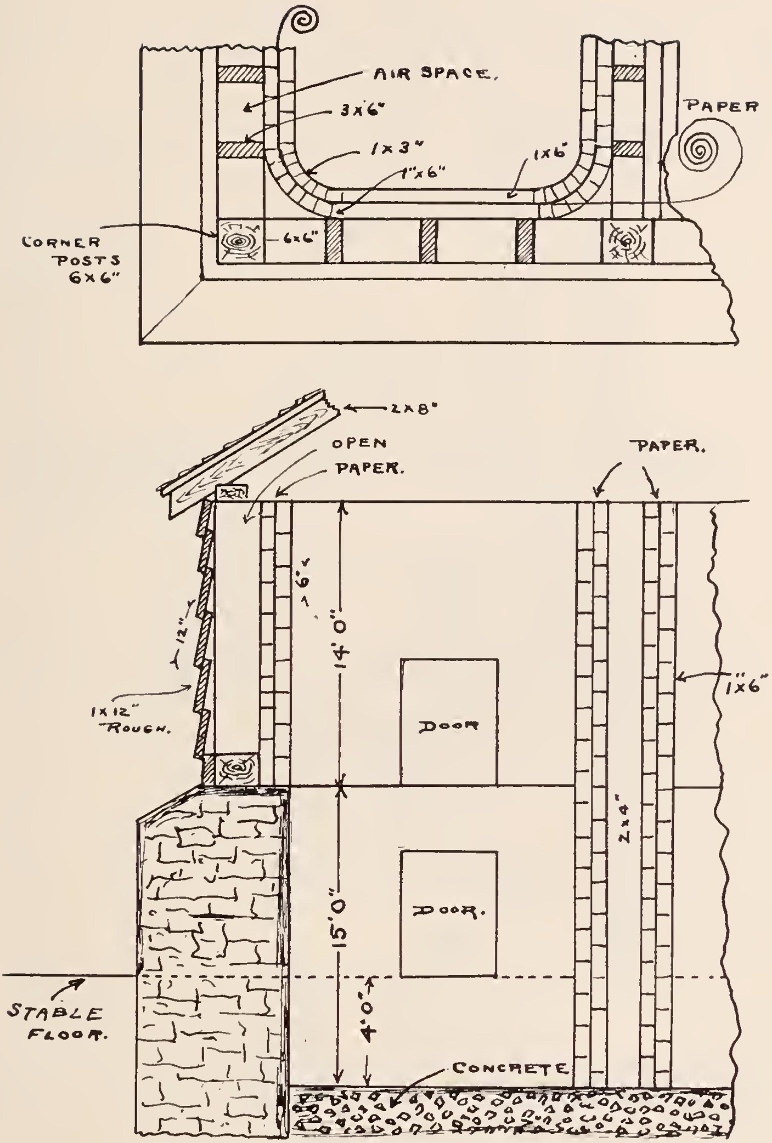
17. Silo of Mr. Elsworth Ecker, New Windsor, Carroll Co. Rectangular combination, 8′ x 28′ x 12″, 6 feet below and 6 feet above ground. See sketch No. 17.

This silo was filled for 18 years, the 19th year did not have enough corn to fill, so it was cut and dried and he has been using it that way ever since, with good results.



No. 16. Silos of Solomon Ecker, New Windsor

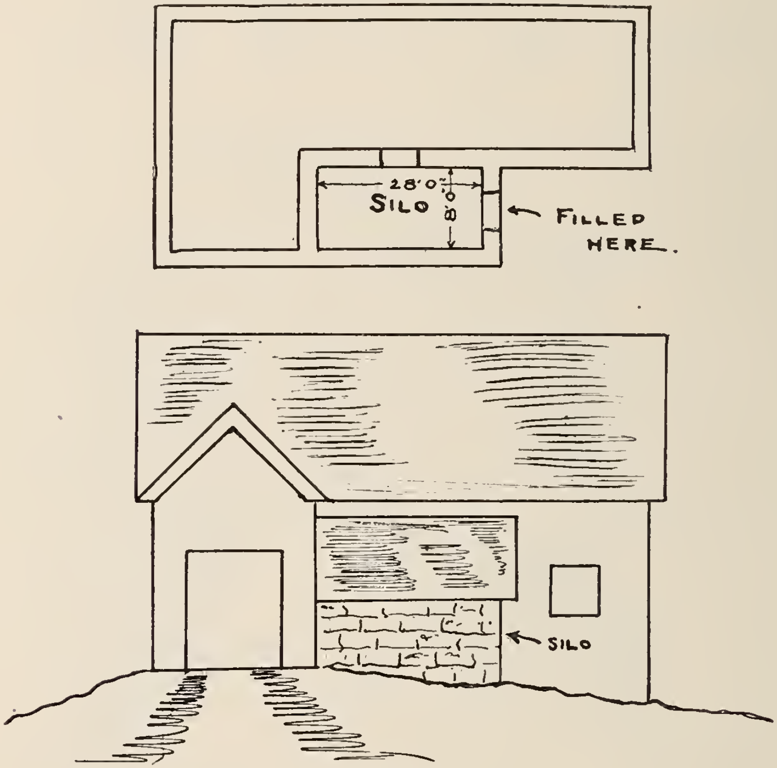
This is said to be the first silo in this section of the country. He previously buried the corn in pits in the ground 6′ x 12′, 5 ft. deep, using boards and dirt to cover; this kept well. This is a dry well-drained soil and the deeper it was buried the better it kept.



Showing Details of the Construction of Silos No. 16.

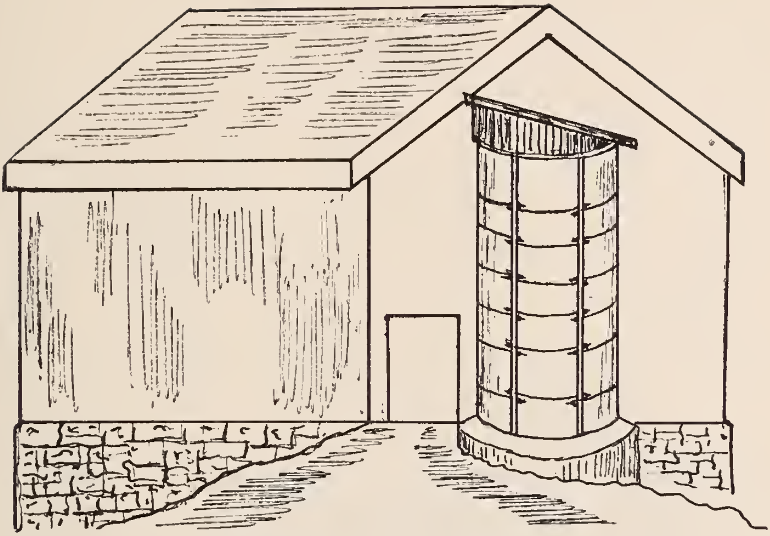
18. Silo on farm of Mr. N. Zile, New Windsor, Carroll Co. Combination round silo, 10′ x 28′, cost $60. Foundation stone (16 perches), 1 foot above and 8 feet below ground. 61 staves 2″ x 6″ rough chestnut (1220 ft.). Requires 4 acres sugar corn (no ears) to fill. Feeds 8 head cattle. In use 3 years.

This silo is constructed like the Smith and Reifsnider silos. There are two staves, 4 x 4 oak. The hoops run through these staves and tighten with a nut, the hoops are in three sections. This silo is in good shape, the chestnut is free from knots and swells, making the silo tight. See sketch No. 18.

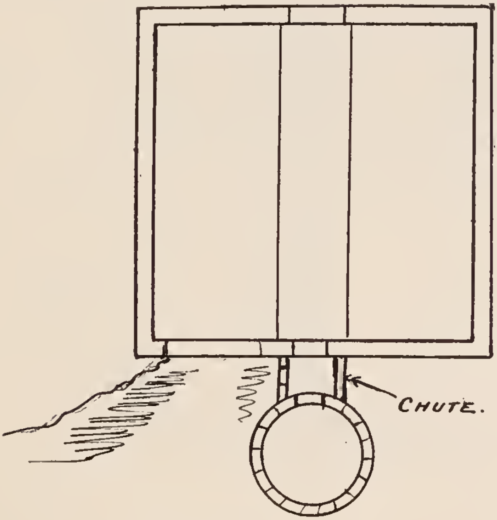


Showing Silo No. 17.

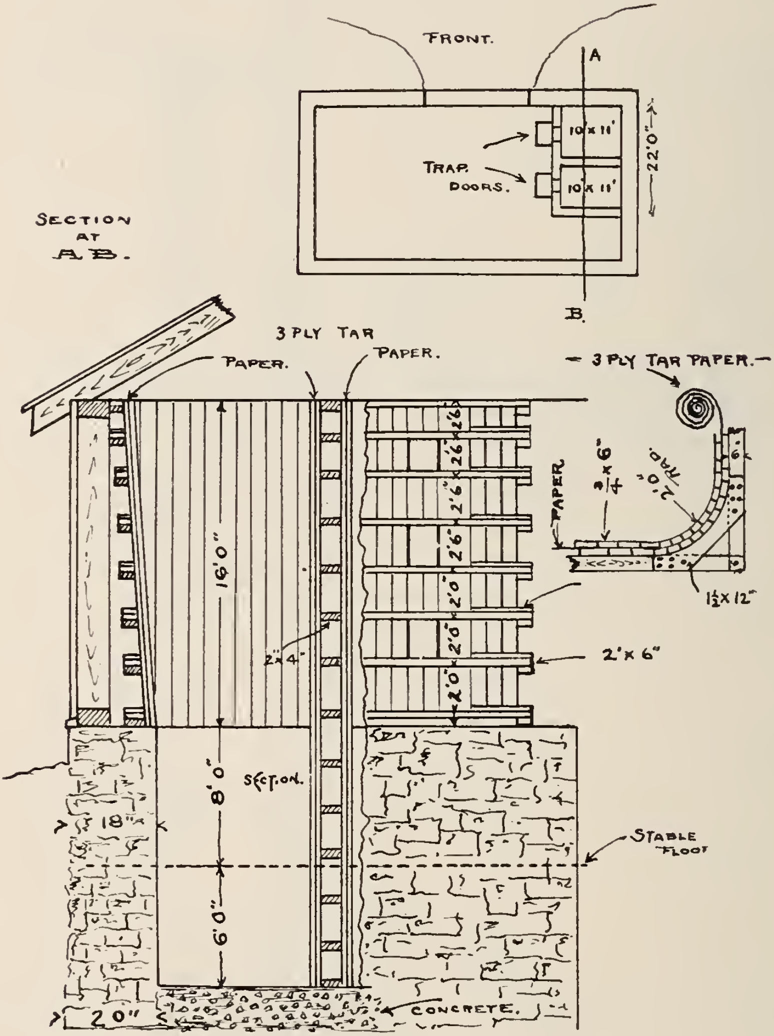
19. Silos of Mr. Jonas Wagner, Medford, Carroll Co. Two rectangular combination silos, 10 ′x 11′–30′, built in barn. Frame construction 24 feet, and masonry 6 feet below ground, cost $65. Requires 5 to



Showing Elevation of Silo No. 18.



Cross Section of Silo No. 18.



Showing Location and Construction of Silos No. 19.

6 acres to fill and takes three men and one boy three days. Keeps silage well. Silo in use 9 years and all parts seem as good as new.

This was built as one silo and a partition put in later. Two sides only are tapered to cause silage to pack, the other sides are perpendicular.

When pit is sunk in ground it must be water proof, if pit fills up with water it spoils silage. Where pit fills with water it is necessary to put in blind ditch. If this cannot be done, and it is impossible to prevent pit from filling with water, the pit will have to be filled to the point where water drains. A lining of good Portland cement will make pit water proof, providing the stone work extends high enough to prevent surface water from flowing in.

Those who have tried silos with a water proof pit find that a silo without a roof causes the pit to fill with water from the rain and snow and the silage is not as good in the pit. Only two without roofs have been found so far and their owners were going to put them on.

Ninety per cent of the stave silos are not air tight at the foundation, the shrinking and swelling of the staves break the cement, thus allowing air to get in and the excessive amount of water to run out. The silage decays from the air being admitted, but does not sour from excessive water, as the water escapes. There is no difference in the silage taken from the top or bottom, that is, when there is no pit. This kind of a silo does not need a roof, but if the air is excluded at the foundation as it should be a roof is essential, or the silage will be slimy and the bottom will not be as good as the top. See sketch No. 19.

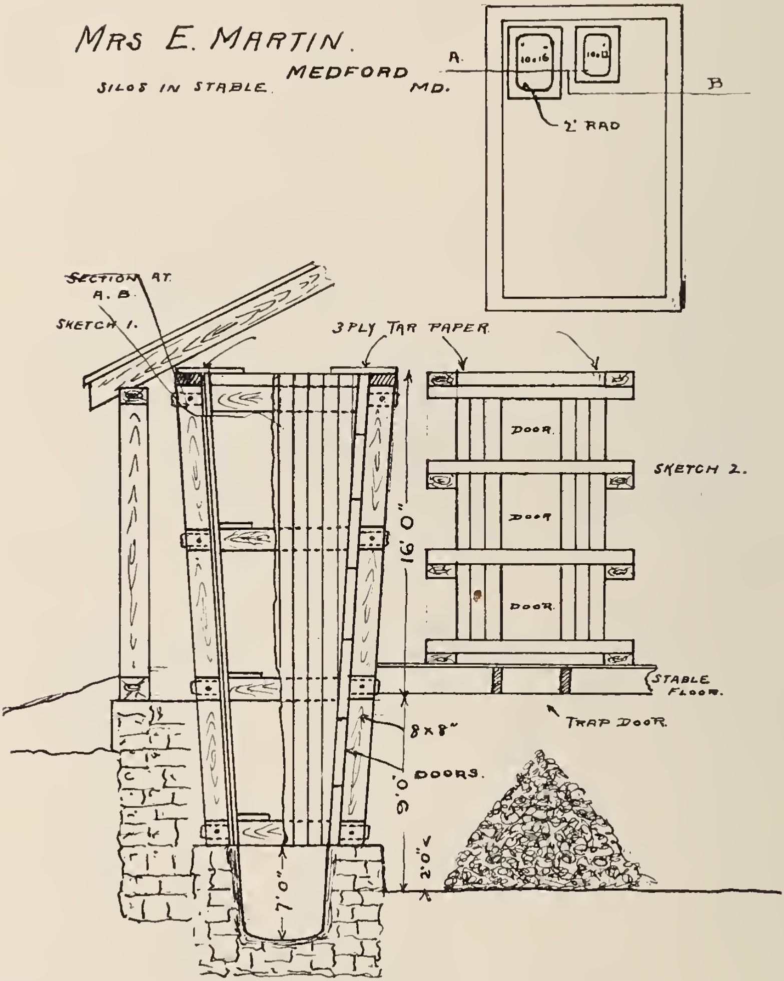
20. Silos of Mrs. E. Martin, Medford, Carroll Co. 2 rectangular combination silos, 10′ x 16′ x 35′ and 10′ x 12′ x 35′, built in barn. Frame construction, 28 feet, and masonry, 7 feet, masonry extends 2 feet above cow stable floor. Silos are narrower at bottom than at top. See sketch No. 20. Silos in use 7 years and in good condition. Keep silage well, but this form would not be built again.

21. Silos of Mr. Ephraim Haines, New Windsor, Carroll Co. 2 round silos, 14′ x 32′. Feeds 25 head cattle. Foundation 2½ feet below ground and 6 inches above. This makes the staves too close to the ground and they are decaying; in use 7 years. See photograph No. 21.

22. Silo of Mr. Frank H. Willet, Medford, Carroll Co. Purchased stave silo in combination with stone, masonry 12′ x 10′, stave portion 12′ x 20′, or total 12′ x 30′. Doors 2 feet apart and 2 feet square. Foundation same as sketch No. 6.

23. Silo of Mr. Ernest Meyers, Medford, Carroll Co. Home-made combination wood and stone silo, 14′ x 35′, 84 staves 2″ x 6″, rough

chestnut (total 1680 ft.). Foundation brick (11,500) 1 foot above and 14 feet below ground. Requires 5 acres and 15 men 2½ days to fill. Feeds 15 head cattle. In use 4 years. Tin roof. Rabbit for doors is beveled and door has corresponding bevel. Paper is used around the interior of silo when filling.



Showing Location and Construction of Silo No. 20.

24. Silos of Mr. Henry Castles, Medford, Carroll Co. Silo No. 1, stave and stone combination, 14′ x 33′ (staves 28 ft.) 5 years old. Silo No. 2 stave 14′ x 28′, 3 years old. See photograph No. 24.

Mr. Castle built one silo and found that he did not have enough silage; he then constructed a second one and found that he had too much. He fed the cows all they could eat, covered with bran and cottonseed meal, three times a day. The cows decreased in their milk yield and were in a poor condition in the spring. His cows consumed 5 or 6 tons of bran in one year, no long feed having been fed.

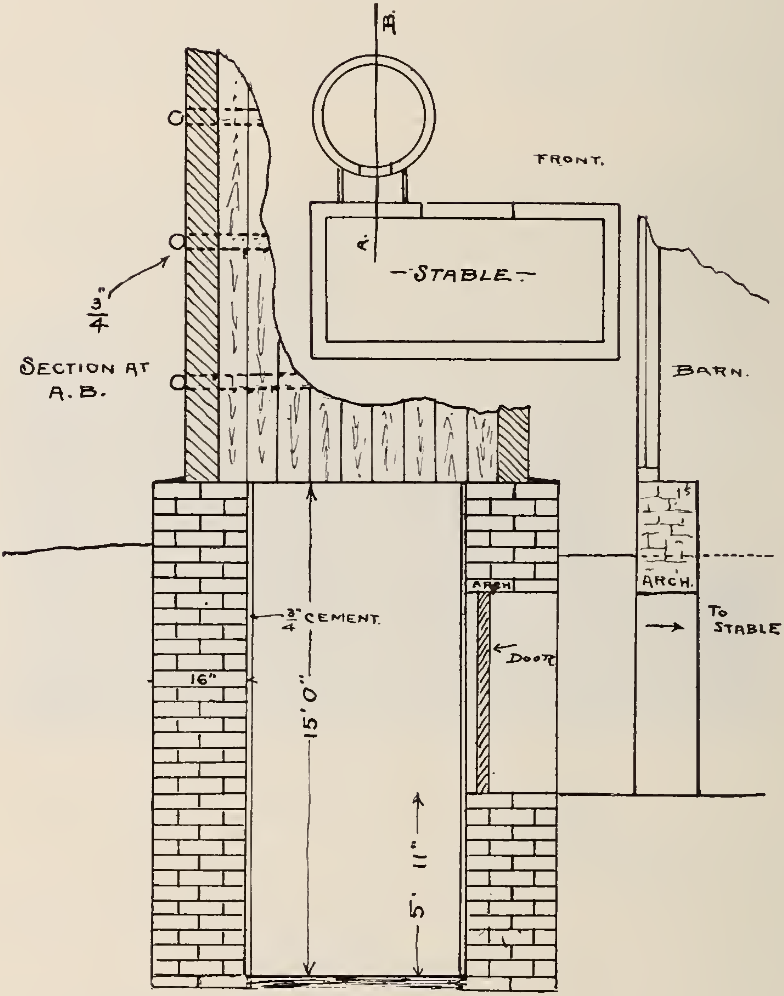
The following year he shucked his corn, getting 100 barrels of corn and 750 bushels of chop, and fed the fodder. He not only increased the milk yield, but the stock were reported to have been in a beautiful condition

No. 21. Silo of Ephraim Haines, Medford, Carroll Co.

The spoiling of the silage in these silos was due to a poorly constructed foundation.

25. Silo of Mr. Joshua Gist, Westminster, Carroll Co. Smith and Reifsnider, stave silo, 16′ x 30′. Feeds 30 head cattle. For foundation see sketch No. 4. See photograph No. 25.

This foundation is two feet above ground, therefore the staves have not decayed at the foundation. This silo is painted with white lead and presents a beautiful appearance. The inside is kept perfectly clean, and it preserves the silage well.



Showing Cross-section of Silo No. 23.

No. 24. Silos of Henry Castle. Medford, Carroll Co.

No. 25. Silo of Joshua Gist, Westminster, Carroll Co.

26. Silo of Mr. William Roop, Westminster, Carroll Co. Combination stone and stave silo, 14′ x 38′, cost $175. Stone foundation (21 perch), 1 foot above and 7 feet below ground. Painted red on outside, 5 years old. Feeds 18 head cattle.

Mr. W. Roop superintends the placing of the fodder when filling and he said this accounts for his not having any silage to spoil. He is able to keep his cows in as good condition as when he did not use silage, and gets more milk from the use of silage.

27. Stacked silage of B. F. Shriver & Bro., Canners at New Windsor, Westminster and Union Mills. See photograph No. 27.

They run the canning refuse through the silage cutter and alternate layers of ground corn cobs and corn husks, and put in large stacks about 20′ x 40′ x 12′ high. It sours to a height of 24 inches from the ground and spoils 12 inches around the circumference. The loss is very great, and the stock do not eat the 24 inches mentioned with a relish. Mr. Shriver said they could afford to allow this portion to spoil as they had an enormous quantity of the silage, but, if he were growing silage under the same conditions as the ordinary farmer he would use silos. Silage use for fattening cattle. Feeds 200 to 400 head each year.

28. Silo of Mr. Wm. H. Geisman, Westminster, Carroll Co. Smith and Reifsnider, stave silo, 12′ x 24′, capacity 50 to 75 tons. Requires 4 to 5 acres to fill. Feeds 14 head cattle. Foundation same as No. 2.

This silo and many others are out of round due to the hoops not being in one piece. The short hoops which draw on the extra thick staves flatten the silo between these staves. Litter in barn yard has decayed this silo at the foundation. He has obtained better results in feeding from the use of silage.

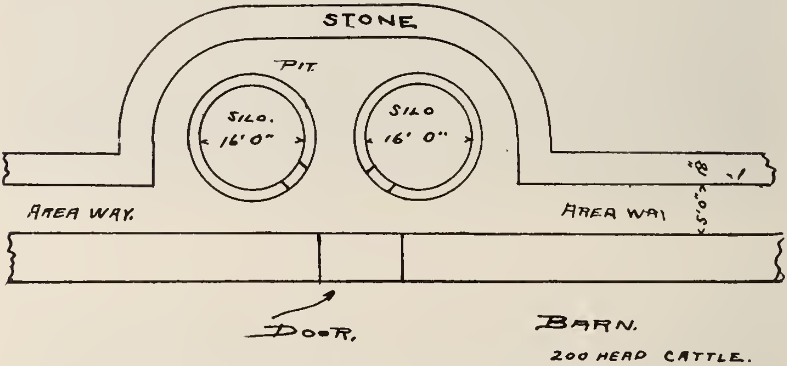
29. Stone silo of Mr. Chas. A. Councilman, Glyndon, Balto. Co. Round stone silo, 20′ x 32′, cost $500, 12 feet below and 20 feet above ground. Walls 2 feet thick. Built from lime stone quarried on the farm. Required 160 perches of stone. Keeps silage well. See photograph No. 29.

30. Rectangular silos of Mr. Chas. A. Councilman, Glyndon, Baltimore Co. Two square silos in barn, 12′ x 18′ x 25′. Pit is 15 feet with 10 feet of wood work, making a total of 25 feet. The silage is hoisted out with a block and tackle and removed from two doors in the frame part of the silo. The frame work is built of 8″ x 8″ corner posts and 4″ x 4″ ties lined on inside with two thickness of lumber with tar paper between. The silage does not keep well in the square corners. Uses corn and cowpeas grown in combination for filling the silos.

No. 27. Stacked Silage.

No. 29. Stone Silo.

31. Silos of Mr. A. W. Fuss, Worthington Valley, Baltimore Co. 2 Smith and Reifsnider stave silos, 16′ x 30′. Feeds 200 head beef cattle. In use 6 years. Foundation 12 inches above ground. Mr. Fuss excavated and formed a circular cavity in front of his barn and placed two 30 feet silos in this excavation. He claims that the silage settles perfectly in a straight stave silo, and that the walls in a combination silo prevent this and causes the silage to spoil. He never has any silage to spoil. The silage is placed in the silo, saucer shaped, and stamped. Eight inches of very green corn cut and placed on top will seal perfectly. See sketch No. 31.



Showing Location and Construction of Silos No. 31.

32. Silo on farm of Mr. J. M. Gardner, Worthington Valley. Stave silo, 12′ x 28′, in use 3 years. Foundation above ground 12 inches and staves show evidence of decay. This silo was without a roof. The superintendent of this farm said that the rain turned the silage dark and the removal of snow caused additional labor and that he was going to put a roof on before refilling. See photograph No. 32.

33. Silos of Mr. S. M. Shoemaker, Eccleston, Baltimore Co. Two Kalamazoo stave silos, 14′ x 32′; two Kalamazoo stave silos, 16′ x 28′ and one Philadelphia stave silo 16′ x 40′.

These silos are mechanically constructed, a concrete pavement surrounds the group, affording a clean surface which allows the spilt silage to be taken up; it also furnishes a perfect drain.

Two of the Kalamazoo silos have a five foot pit, the silage taken from the pit is sourer than those having no pits.

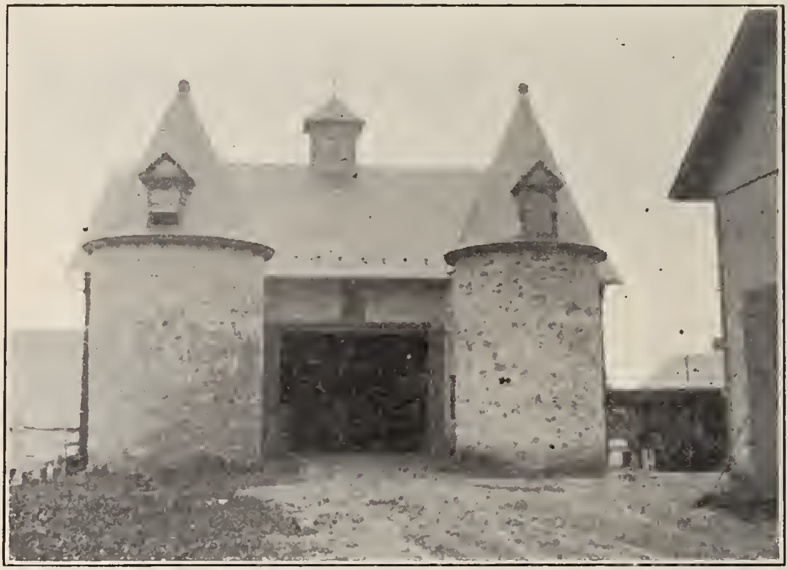
Those having no pits are built like No. 2. Those with pits are built of stone lain in cement; silage is thrown out.

No. 32. Silo of J. M. Gardner, Worthington Valley, Baltimore Co.

No. 33. Silos of S. M. Shoemaker, Eccleston, Baltimore Co.

One of the 14′ x 32′ Kalamazoo silos is lined with brick laid the four-inch way, and the brick is lined with cement. This silo is a good keeper, but will not stand when staves decay. The gain in keeping does not justify the expense.

34. Silos on the farm of Mr. Harry D. Hanway, Belair, Harford Co. No. 1, stone silo, 14′ x 30′. No. 2, stone silo 12′ x 30′, walls 2 feet thick, in use 8 years. See photograph No. 34. No. 3, Philadelphia stave silo, 18′ x 30′ with foundation like sketch No. 2. This silo is in the barn, and keeps better than the stone ones. The stone sweats on inside and silage spoils around the edges. The stone silos are built in front of the barn, one on each side of entrance; there is a 12-inch revolving ventilator on each one. These silos extend to bottom floor of stable and have two small doors 2′ x 2′, and a large door at the bottom entering stable.

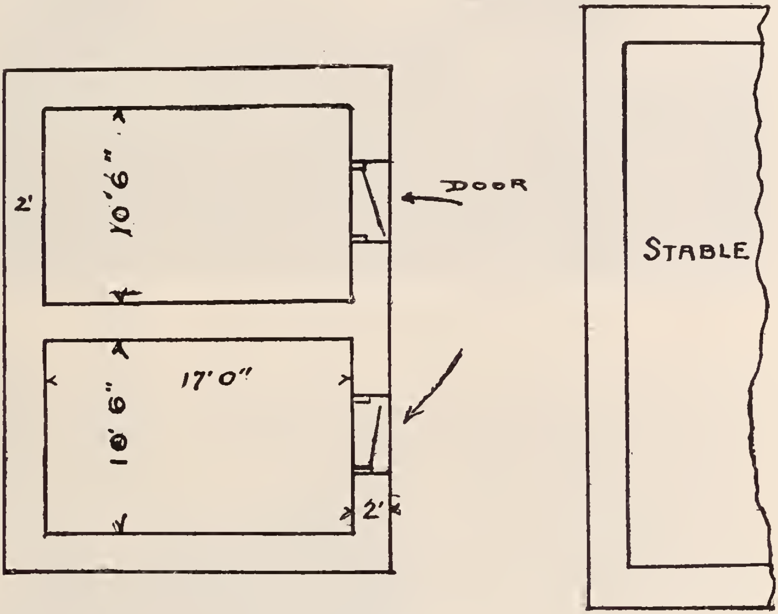


No. 34. Silos of Harry D. Hanway, Belair, Harford Co.

35. Silo of Mr. David Hanway, Bel Air, Harford Co. Square stone silo, 12′ x 12′ x 24′, walls 18″ thick, estimated cost $150. Mr. Hanway does not believe that stone silos are the best preservers of silage, and is going to construct a new silo of wood, 16′ x 16′ and 26 feet high. This silo is to have a stone foundation but it is not to be a combination silo.

36. Silos of Mr. Henry Burns, Bel Air, Harford Co. 2 rectangular stone silos, 21′ x 27′ x 18′ (divided into 2 silos, see sketch and photograph), walls 2 feet thick. Silo is 12 feet above and 6 feet below ground. In use 7 years.

This silo has a stone partition making two silos 12½′ x 17′ x 18′. There is one door in each silo opening under shed (see photo). These silos are filled every year. Mr. Burns is a dealer in stock, and finds silos profitable to stock raisers. These silos preserve the silage with but little decay.



Floor Plan of Silos No. 36.

37. Mr. William Grant, Bel Air, Harford Co., uses a 12′ x 26′ Philadelphia silo, set on a foundation that gives 4½ feet of a pit. In use 3 years, feeds 18 head cattle. Reports the silage not as good from the stone as from the wood portion.

38. Silo of Nathan Oldfield, Bel Air, Harford Co. Philadelphia stave silo, 16′ x 30′, with 8 ft. pit. Note roof construction as shown in photograph No. 38.

39. Silo of Mr. P. H. McCormick, Bel Air, Harford Co. Square stone silo constructed in end of barn, 15′ x 15′ x 27′, walls 2 feet thick. In use 20 years. This silo has no opening except at top. They use a

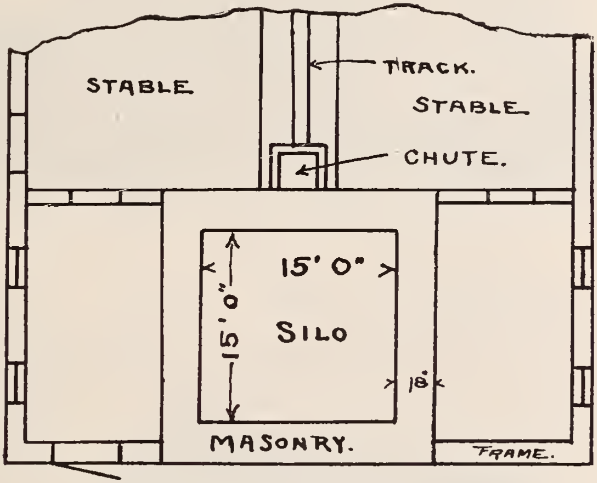
No. 36. Silo of Henry Bruns, Belair, Harford Co.

No. 38. Silo of Nathan Oldfield, Belair, Harford Co.

sugar barrel rigged on a hay rope similar to a hay fork, for removing the silage. The silage is better at the bottom than at the top. There is a chute from the top of the silo to the stable, and silage is conveyed into a car on a track which is used in the stable, feeding from both sides of car.

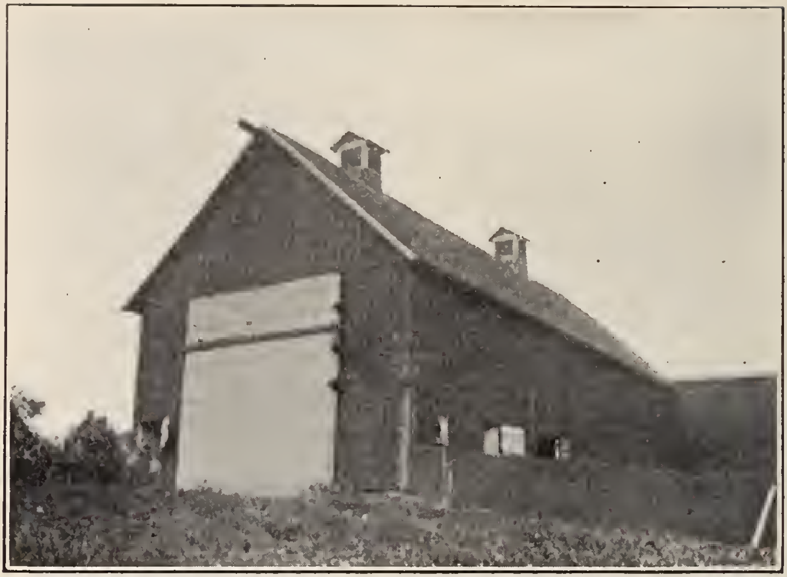
The braces and rods seen in the photograph are to support the masonry which is cracked.

40. Silo of Mr. J. L. McCormick, Bel Air, Harford Co. Photograph No. 40 represents a square silo, 10′ below ground stone, 6′ above ground frame. Silo 10′ x 10′, square corners. The frame work is constructed of studding 3″ x 4″ lined on outside with 1″ x 12″ stock lumber and stripped. The inside is lined with rough board, interlined with tar paper, and horizontally lined with $\frac{7}{8}$″ tongue and grooved yellow pine. The silage keeps well, but is best when removed to one foot below masonry. Great care must be taken when filling to prevent silage from spoiling in corners.

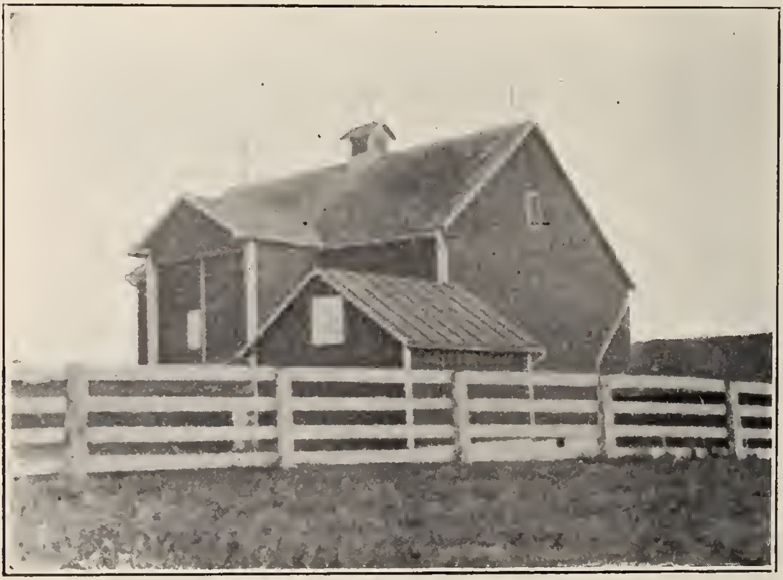


Showing Floor Plan of Silo and Stable. Silo No. 39.

41. Silo of Mr. J. L. McCormick, Bel Air, Harford Co. Sketch No. 41 represents a square silo 8′ x 8′ x 16′, three feet of which is above the ground. This is built of stone, the masonry is two feet thick. It has a gable roof and is filled with ice when silage is removed. This combination silo and ice house preserves the silage well, a small amount spoiling in the square corners.



No. 39, Silo of P. H. McCormick, Belair, Harford Co.



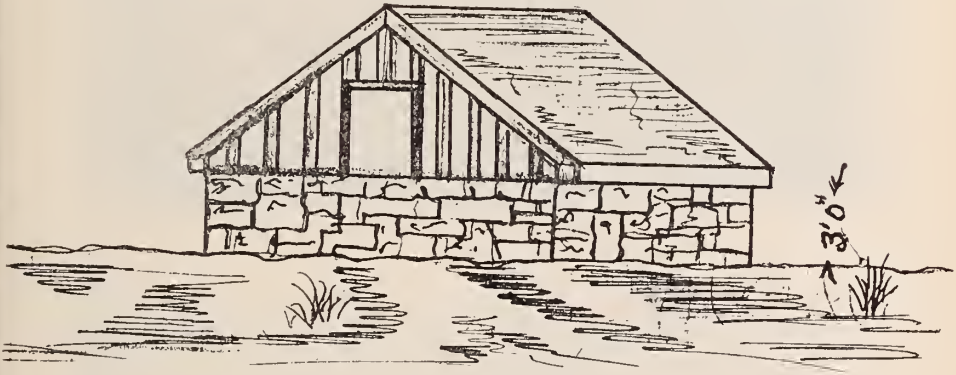
No. 40. Silo of J. L. McCormick, Belair, Harford Co.
(Silo is the low building near the fence.)

42, 43, 44 and 45. Silos on Filston Farm, Glencoe, Balto. Co. Photograph No. 42 represents on the left rectangular stone silo, 20′ x 60′. Abandoned on account of too much surface to spoil.

Round silo next to rectangular silo is 16′ x 30′, under same roof covering a 14′ x 30′ silo. These are manufactured silos, make not known. They are not true (round) due to being blown down and reconstructed. Foundation construction, see Photograph No. 2.

Photograph No. 43 represents two octagon-shaped silos, 18′ x 30′, 25 feet high, no pit. Saucer shape foundation of concrete.

These silos are said to preserve the silage well, but are not as good as the round as some spoils in the corners.

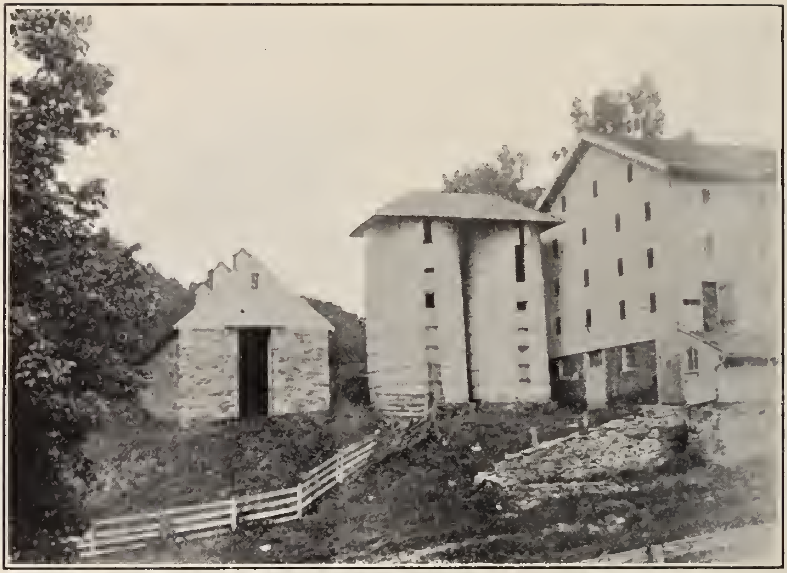


Sketch of Silo No. 41.

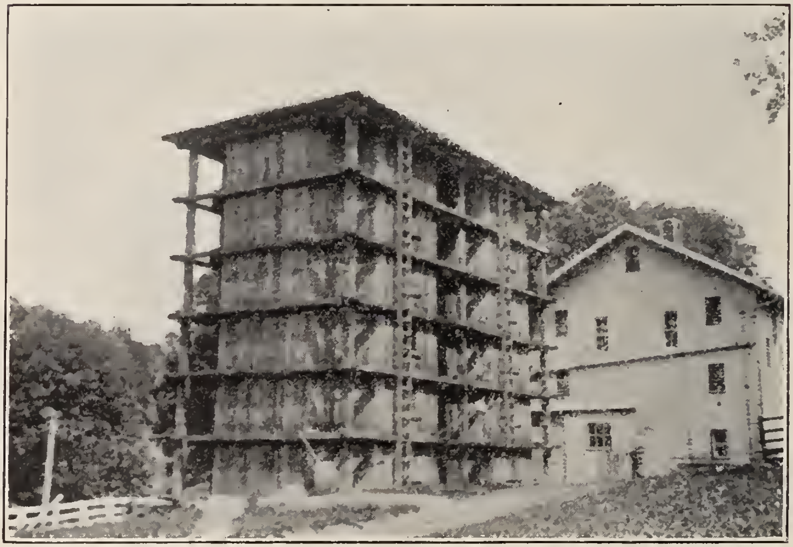
Corner and center posts are 8″ x 8″. Ties are 4″ x 8″ half-lapped. Two thicknesses of 1″ x 6″ rough yellow pine is used for lining with tar paper between. The joints are broken by placing inner lining three inches in advance. The doors are hinged vertically and open from inside. These doors lap at an angle of 60° in center; two doors to an opening.

Photograph No. 44 represents two Philadelphia silos, 16′ x 30′. Foundation stone, see Photo No. 2. These silos present a fine appearance and are said to be fine preservers of silage.

45. Two round silos stave, 16′ x 26′. They are built in the stable of 1″ x 12″ rough lumber used as vertical staves, with ¾″ round iron hoops placed 4 feet apart. These hoops are in two sections. The couplings for hoops were forged at the smith shop. Foundation concrete, see Photo No. 2. Each silo has three doors 3 feet long and 22 inches wide. These silos are good preservers of silage.

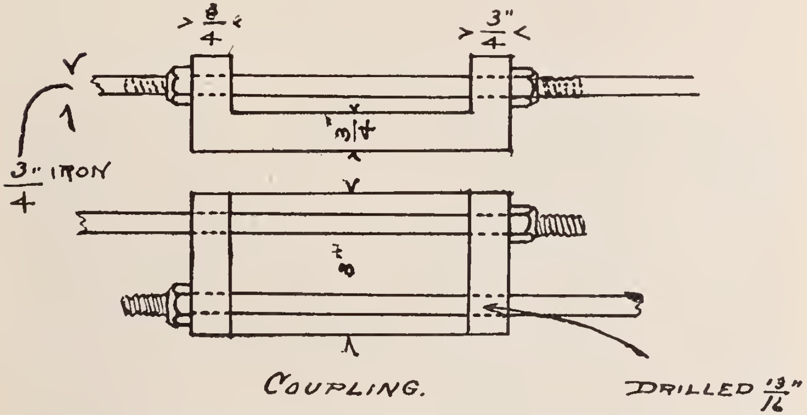


No. 42. Filston Farm Silos, Glencoe, Baltimore Co.



No. 43. Filston Farm Silos, Glencoe, Baltimore Co.

No. 44. Filston Farm Silos, Glencoe, Baltimore Co.



Couplings for Hoops for Silo No. 45 (forged at smith shop).

46. Silo of Mr. U. H. Tarbert, Glencoe, Baltimore Co. Photograph No. 46 represents a round stone silo, wall two feet thick. 16 feet in diameter, 24 feet visible in photograph, 8 feet to bottom of cow stable, 8 feet below bottom of cow stable, total height 40 feet. This silo preserves silage well. Built in 1899. Feeds 30 head cattle.

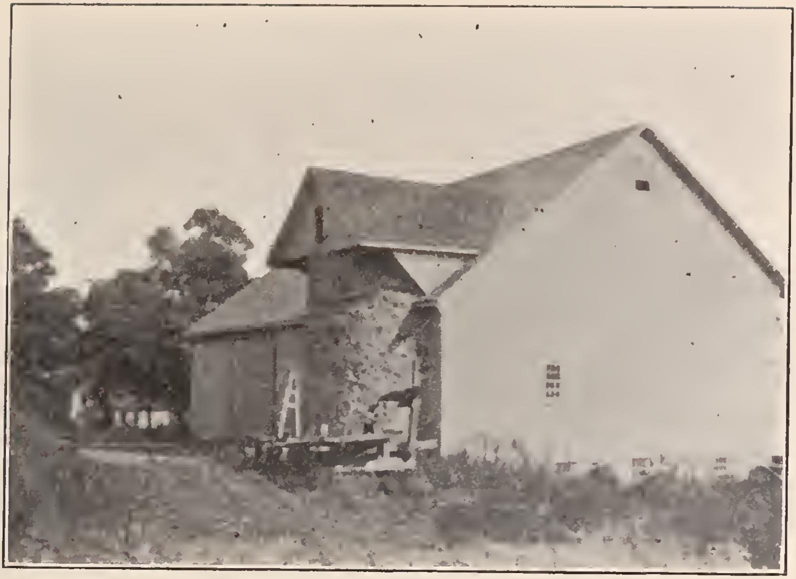
This silo was built partly in old barn which was destroyed by fire, the silo and its contents were well preserved, and new barn, which appears in photograph, was constructed around the silo.

47. Silo of Mr. L. M. Bacon, Monkton, Baltimore Co. Photograph No. 47 represents a square stone silo, 25′ x 25′ inside, and has round corners constructed with a two-foot radius. 15 feet above ground, 8 feet to bottom of cow stable and 7 feet below bottom of cow stable, making a total height of 30 feet. Seven years old, cost about $800, stone and farm labor not included. Requires 20 acres to fill. This silo is a good preserver of silage.

This is a fine piece of masonry. Walls are 2 feet at top, tapered to 2½ feet at bottom. Door from bottom to cow stable. Silage would have to be hoisted out if it was desired to have it all preserved, but they excavate a cavity from door at bottom to the top of the silage and then remove the top, passing the same down the excavation and deliver through door to cow stable. The silage on the edges of the excavation spoils from exposure, but the convenience justifies the loss. This is considered a bad practice as a series of doors would preserve the silage, but too many doors would weaken the masonry.

48. Silo of Mr. H. A. Mathews, Monkton, Baltimore Co. Buffalo, N. Y. stave silo, 14′ x 30′ on stone foundation with 10′ pit, giving a total depth of 40 feet. Same style of foundation as sketch No. 6. Cost about $250. Wood staves too near ground and are decaying. See Photograph No. 48.

49. Silo of Mr. W. H. Curry, Monkton, Baltimore Co. This is a rectangular combination silo, 22′ x 26′; 18′ frame, 9′ stone, making a total height of 27′. Corners are round with 2 feet radius. Built in 1892. The interior is lined with boards, double lapped, with lathes nailed vertically to receive lathes which are nailed horizontally. These lathes are plastered with cement, thus making a perfectly air tight silo which preserves the silage well. Three thicknesses of newspaper is lapped on inside of doors when filling. This was the only silo found built in this manner, except a round silo built by Mr. G. E. Shelly who adopted Mr. Curry's method of cementing. This is an excellent idea, but great care must be taken in removing silage, or the cement will be broken.



No. 46. Silo of U. H. Tarbert, Glencoe, Baltimore Co.

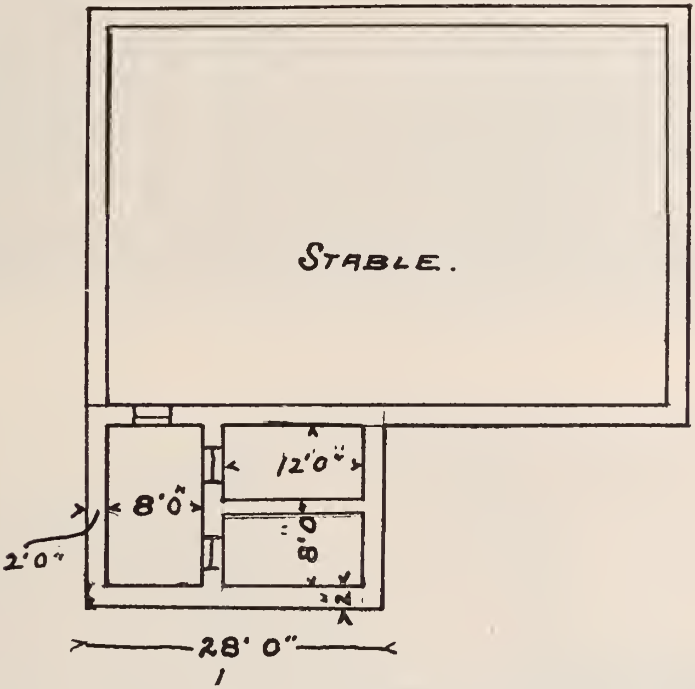
No. 47. Silo of Louis M. Bacon, Monkton, Baltimore Co.

No. 48. Silo of H. A. Mathews, Monkton, Baltimore Co.

No. 49. Silo of W. H. Curry, Monkton, Baltimore, Co.

The silage is kept 12 inches in advance in the center of the silo when filling, this prevents the silage from spoiling on the sides.

Mr. W. H. Curry has the finest silage corn that was found in the state. Average height, 15 feet. Has from three to five ears on many of the stalks. It is planted with drill 13 inches apart in rows 3 feet 6 inches apart. This was the only silage corn that was found free from weeds and grass. See photograph No. 49a.



Showing Cross Section and Location of Silos No. 49.

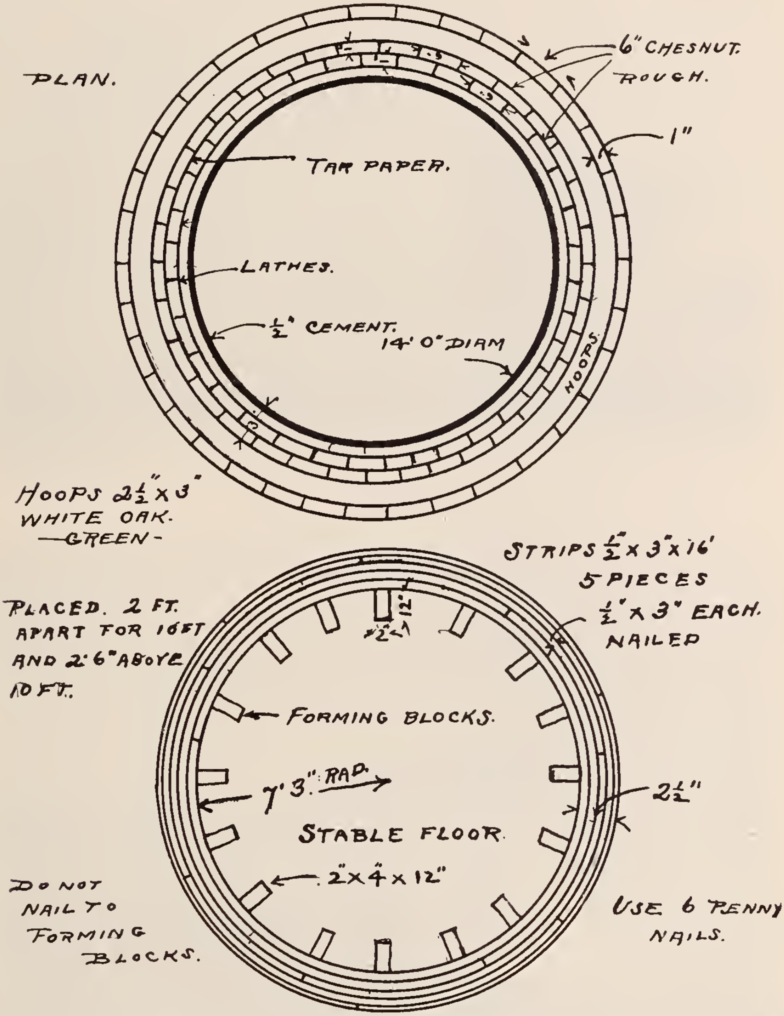
50. Silo of Mr. H. Nelson, Monkton, Baltimore Co. This is a round stone silo, 13′ above ground and 12′ below ground, making a total height of 25 feet. Diameter 13′ inside, 18-inch wall. This silo is a perfect preserver. There is a perfect fitting concave door on the level with ground which is the floor of his cow stable. Required 65 perch of stone.

51. Silo of Mr. Geo. E. Shelley, Monkton, Baltimore Co. Home-made combination stone and stave silo, 14′ x 28′ 20 ft. staves on an 8′ pit. Requires 5 acres to fill.

No. 49a. Silage Corn of W. H. Curry, Monkton, Baltimore Co.

No. 50. Silo of H. Nelson, Phoenix, Baltimore Co.

The staves on outside are chestnut, 6″ wide, nailed on vertically 16′ long, and 4′ nailed above. The four feet pieces are nailed on so as to lap on the 16′ pieces allowing the water to run off.



Showing Method of Making Hoops and Details of the Construction of Silo No. 51.

The interior is vertically lined with 6″ chestnut, tar paper placed, and again lined with 6″ chestnut, joints being broken, then the vertical lathes are placed, followed with horizontal and then plastered with cement. This is a perfect silo, the bottom is cemented in saucer shape. The construction is similar to T. J. Haines No. 6, except that board staves cover the outside and the inside is plastered. This silo is not affected by atmospheric conditions. The cement is not thick enough to cause it to sweat, and it is as perfect a preserver as the stone silo there being no decay from sweating. This manner of construction is the only perfect combination silo that was found. The stone and frame work remain flush, thus allowing the silage to settle evenly which is not the case in the stave silos, as the silo has to be placed in the center of the wall, if placed too near the pit the shrinkage will allow the hoops to pull the staves to a smaller diameter than that of the pit and thus cause a leak at the foundation, this unevenness allowing the silo to fall or blow over. Every other space between hoops is a door, paper is used between door and joint. Stave silos with hoops ought not to be used as a combination silo.

The following is a list of the material required:

150 P. ½″ x 3″ x 16′ white oak for hoops.
50 P. 1″ x 6″ x 16′ chestnut staves } outside.
50 P. 1″ x 6″ x 4′ chestnut staves }
50 P. 1″ x 6″ x 16′ chestnut staves } inside
50 P. 1″ x 6″ x 4′ chestnut staves } 1st course.

One 16′ piece nailed from top and 4′ at bottom. Next stave 16′ from bottom and 4′ on top.

900 sq. ft. of tar paper.
50 P. 1″ x 6″ x 16′ chestnut staves } Inside
50 P. 1″ x 6″ x 4′ chestnut staves } 2d course.
2,600 rough lathes.
20 P. 2″ x 4″ x 16′ rafters for roof.
200 ft. 1″ x 6″ sheathing.
2,000 shingles.
18 in. stone wall.
24 perch of stone or concrete.

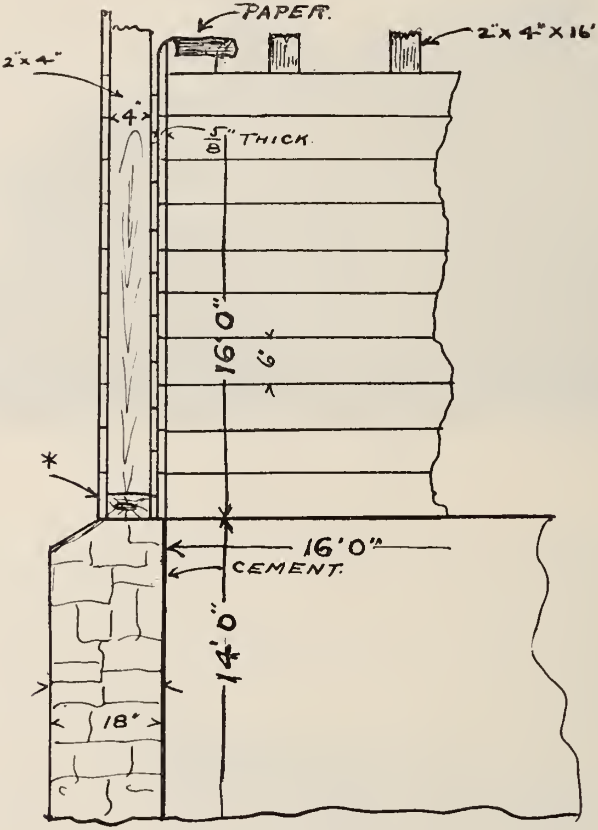
Doors are concave built of staves lined with paper placed on two concave battens.

52. Silo of Mr. Albert Lintz, Phoenix, Baltimore Co. American Farm Co. (Corbett, Md.), stave silo, 14′ x 24′. Foundation same as sketch No. 2. Inside of silo was coated with gas tar which proved to be undesirable, as the silage adheres to the tar. This silo blew down twice which necessitated the bracing with the two large posts shown in the photograph (No. 52).

No. 51. Silo of G. E. Shelley, Phoenix, Baltimore Co.

No. 52. Silo of Albert Lentz, Phoenix, Baltimore Co.

53. Silo No. 1 of Mr. T. V. Richardson, Phoenix, Balto. Co. Modified Wisconsin style silo. Combination stone and frame, 16′ x 30′. Frame 16′ high. Stone portion, 14′ deep.



Showing Details of the Construction of Silo No. 53.

This silo is horizontally lined on inside and out with 6″ boards $\frac{5}{8}$″ thick, this lining on inside is covered with tar paper and again horizontally lined with $\frac{7}{8}$″ x 6″ boards. Oak is the best for this purpose.

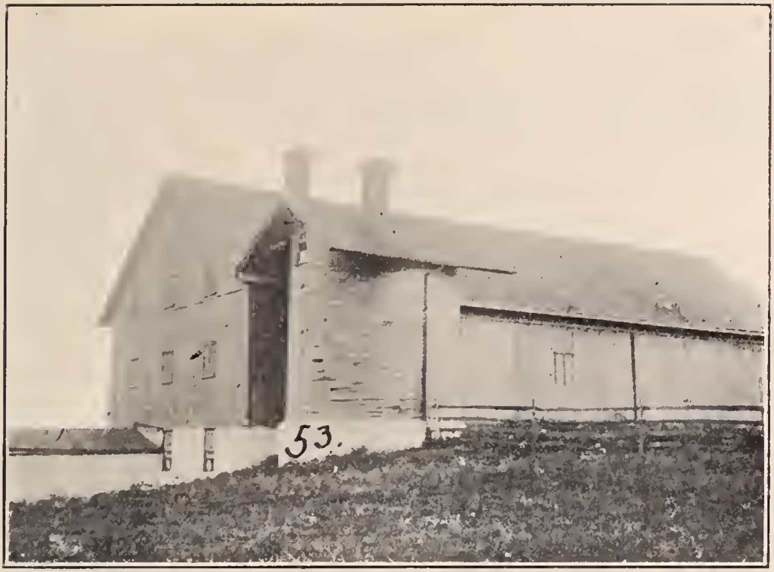
45 Perch of stone required (18″).

48 P. studding 2″ x 4″ x 16′, Va.

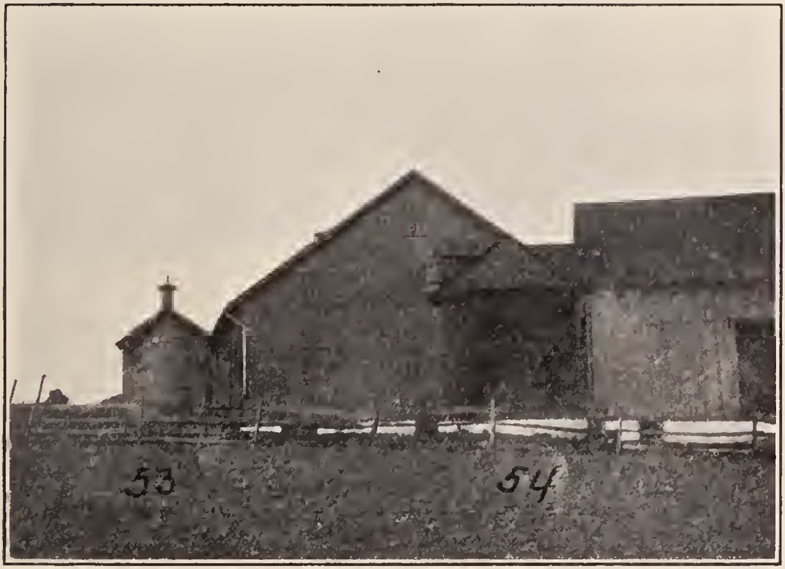
800 sq.ft. tar paper required.

2,500 sq. ft. $\frac{5}{8}$″ x 3″ x 16′ boards.

See sketch and photograph No. 53.

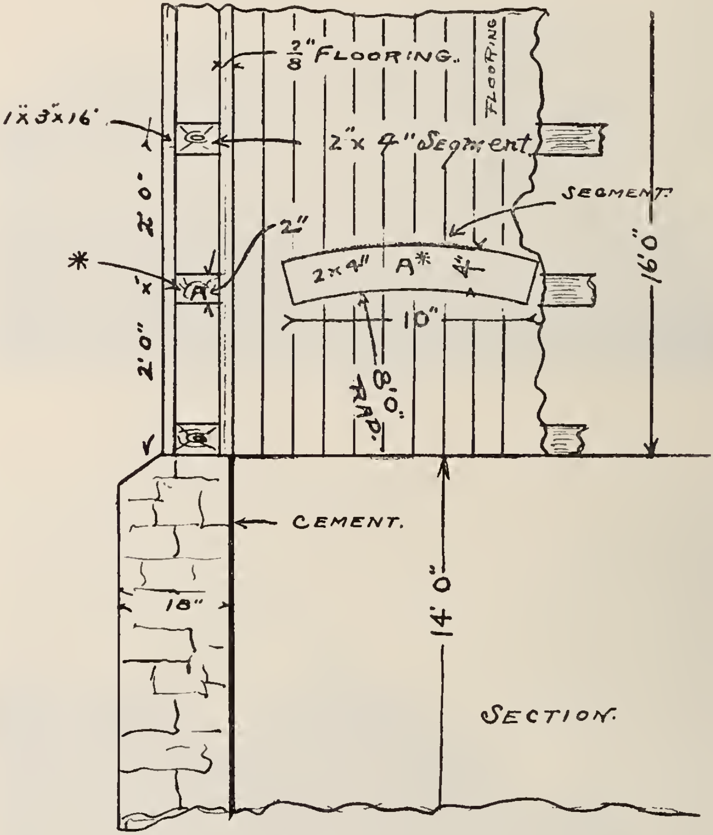


No. 53. Silo of T. V. Richardson, Phœnix, Baltimore Co.



Nos. 53 and 54. Silos of T. V. Richardson, Phœnix, Baltimore Co.

54. Silo No. 2 of Mr. T. V. Richardson. Combination frame and stone silo, size 16′ x 30′. The frame of this silo is built after the general suggestions of Mr. John Gould of Ohio, as given at the Farmers Institutes in Maryland and described in Hoards Dairyman, a copy of which is found on page 72 of this Bulletin.



Showing the Details of Construction of Silo No. 54.

The only difference between No. 1 and No. 2 is that the outside and inside are lined vertically instead of horizontally. The inside is lined with flooring (tongue and grooved), no paper.

45 Perch of stone.

48 P. Ver. studding 2″ x 4″ x 16′ Va.

10 P. Hor. studding 2″ x 6″ x 16′ Va. (segments).

To be nailed horizontally between studding two feet apart to receive inside and outside lining.

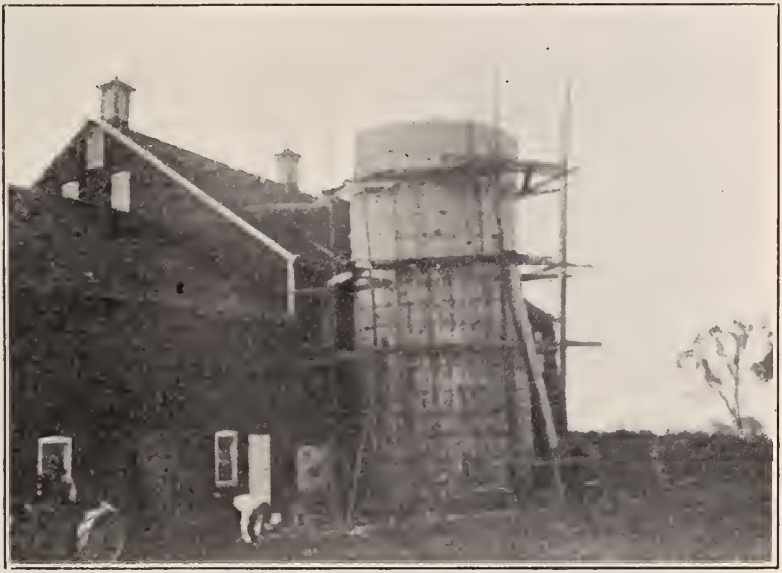
800 sq. ft. 1″ x 3″ x 16′ boards for outside.

800 sq. ft. $\frac{7}{8}$″ x $2\frac{1}{2}$″ x 16′ flooring (tongue and grooved) for inside.

See sketch and photograph No. 54.

55. Economy silo, 16′ x 35′ in course of construction on farm of Mr. C. E. King, Germantown, Montgomery Co.

56. Silo on farm of Charles R. Darby, Bucklodge, Montgomery Co. Wisconsin type of silo, 18′ x 25′, built after plans given in U. S. Department of Agriculture Farmers Bulletin No. 32.



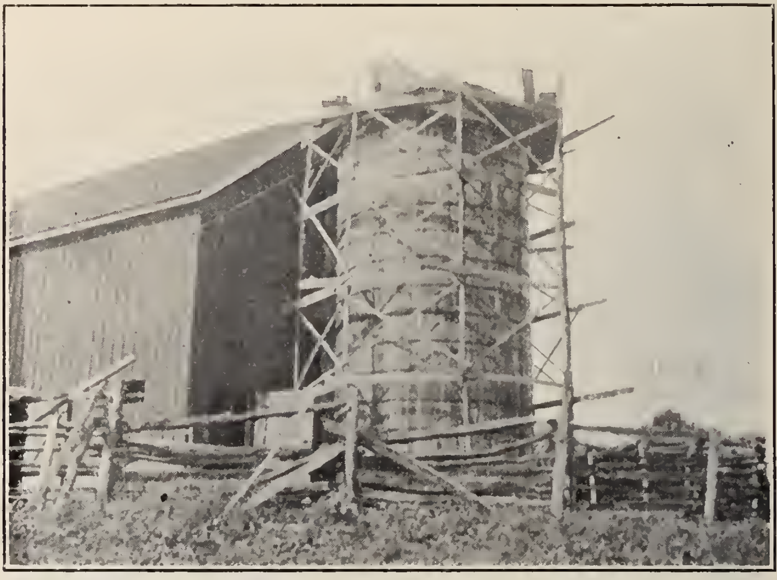
No. 55. Silo of C. E. King, Barnsville, Montgomery Co.

Built of studding horizontally lined on outside. Inside is lined to one-half of height vertically, and the top half is lined horizontally. This lining on the outside is double and has paper between. For construction see sketch and photograph No. 53.

57. Silo of Mr. Louis Pool, Germantown, Montgomery Co. Stave silo, 10′ x 20′, 3 years old. Mr. Pool places a series of braces across the diameter of his silo after the ensilage is removed and thus braces the silo which prevents it from blowing down; the braces are removed before filling.

58. Silo of Mr. J. L. Nicholson, Bucklodge, Montgomery Co. "Economy" silo, 14′ x 28′, one year old. For foundation see sketch No. 2. Tried one year without a roof, and scaffolding appearing in photograph was for the purpose of putting roof on and remains for the purpose of painting.

59. Silo of Mr. M. E. Wade, Bucklodge, Montgomery Co. Philadelphia stave silo, 16′ x 30′. Foundation same as sketch No. 2. Silo two years old and has given good satisfaction.



No. 58. Silo of J. L. Nicholson, Bucklodge, Montgomery Co.

60. Silos of Mr. David Reinhardt, Boyds, Montgomery Co. Two stave silos 16′ x 30′. For foundation construction see sketch No. 2. 175 head of cattle on place; barn holds 90 head,

There is a cement mixing trough, 3′ x 6½′ x 16′ in front of silos in the barn, one-half silage and one-half corn fodder are mixed with steam and fed warm.

There is a steam plant and engine used to run the separators. This plant is conveniently arranged and run in a business-like manner. See photograph No. 60.

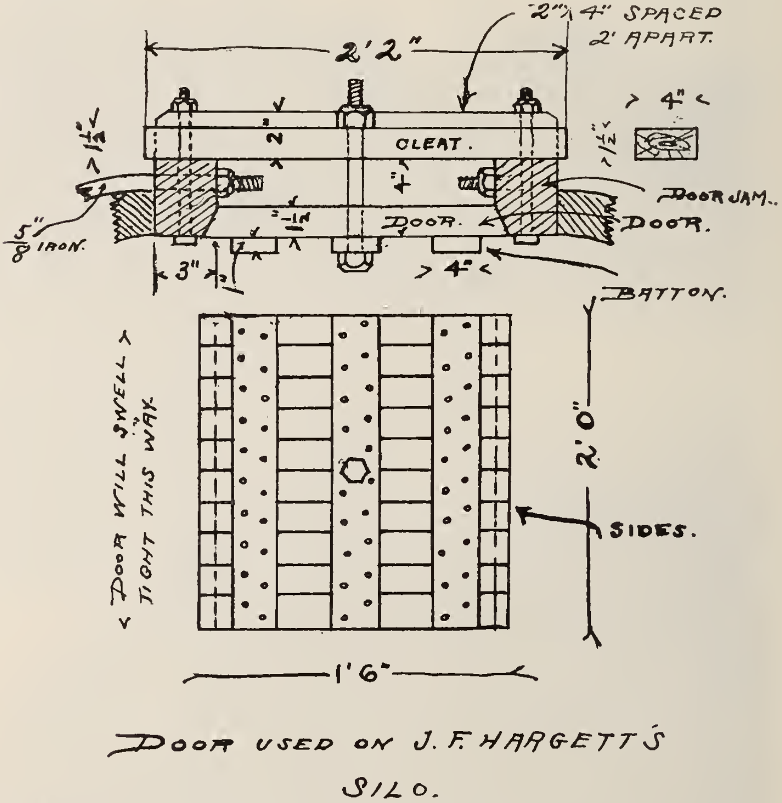
61. Silo of Mr. Eugene Macafee, Boyds, Montgomery Co. Philadelphia stave silo, 14′ x 30′. Foundation same as sketch No. 2. Shows

No. 60. Silos of David Reinhardt, Boyds, Montgomery Co.

No. 61. Silo of Eugene Macafee, Boyds, Montgomery Co.

blower in place for filling. This is a well-placed silo and when on a foundation two to three feet above ground gives better success than the combination silo.

62. Silo of Mr. John F. Hargett, Germantown, Montgomery Co. Home-made stave silo, 16′ x 30′. Foundation same as sketch No. 2 or No. 3. 8 perches of stone required for No. 2. 150 pieces 2″ x 4″ x 30′ chestnut, native sawed, lumber used in the rough. The staves are not tongue and grooved. Ten ¾″ round iron hoops are used.



Door used on J. F. Hargett's Silo No. 62.

There are a number of this style home-made silos in the vicintiy of New Windsor which are giving perfect satisfaction. See sketch and photograph No. 62.

63. Photograph shows silo 16′ x 30′ of Mr. G. T. Shafer, Germantown, with gable roof which affords ventilation. Note wire guy lines to prevent silo from blowing down.

No. 62. Silo of John F. Hargett, Germantown, Montgomery Co.

No. 63. Silo of F. G. Shafer, Germantown, Montgomery Co.

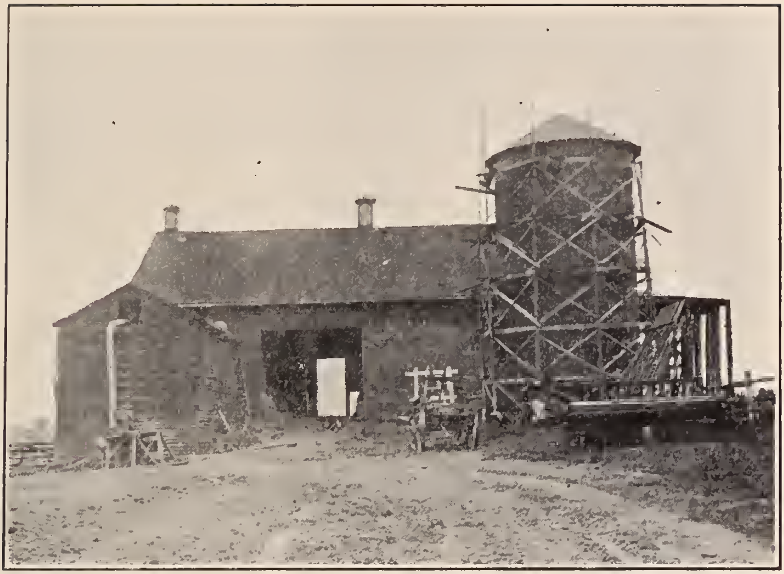
64. Silo on Westward farm of J. B. Diamond & Sons, Gaithersburg, Montgomery Co. Harder, Cobelskill, N. Y., stave silo, 22′ x 40′. Cost about $500. Required 3 men four days to erect. Photograph shows scaffolding remaining for use of painters. Foundation 3′ below and 1′ above ground. The barn shown in the photograph is 34′ x 168′ and houses 125 cows.

65. Silo on East farm of J. B. Diamond & Sons, Gaithersburg. Harder stave silo, 18′ x 36′. Foundation 12″ above ground, stone. The scaffold is still in place, which was used to reconstruct the silo, it having been blown down.

No. 64. Silo of J. B. Diamond & Sons, Gaithersburg, Montgomery Co.

The frame work of an abandoned rectangular silo stands to the right of the photograph at the end of the barn. To the left is a rectangular silo still in use, the blower is in place for filling. This silo is 15′ x 25′ x 25′ and had square corners, but was improved by reconstructing into an octagon shape which keeps silage fairly well. This has a stone foundation and the silo is all above ground.

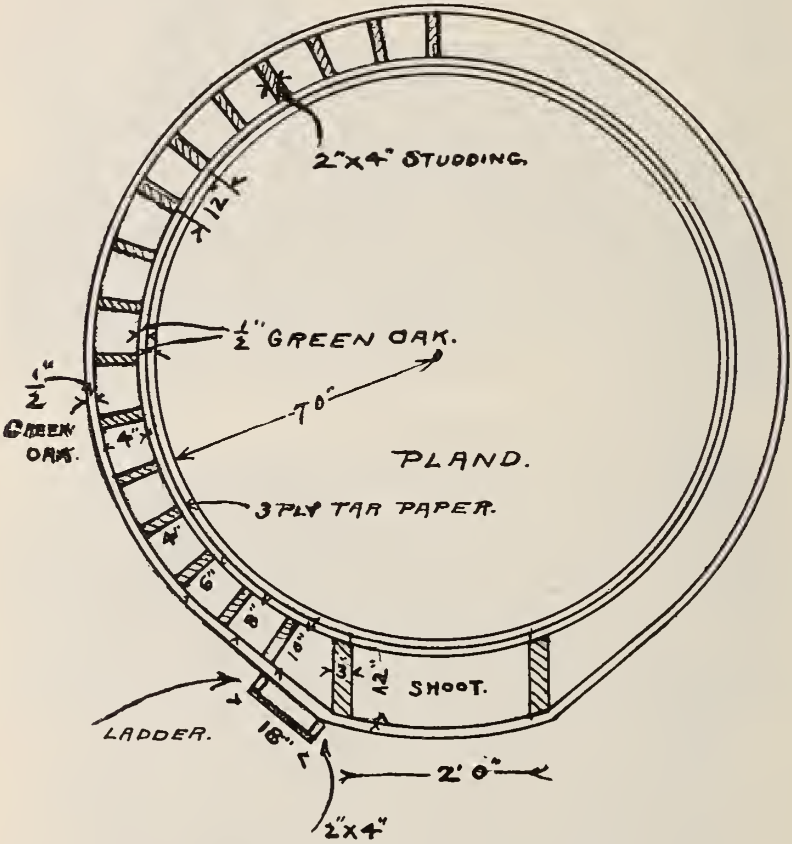
66. Silo of Mr. Robert H. Miller, Spencerville, Montgomery Co. Home made, 14′ x 32′. Built after a modification of the Wisconsin style from lumber sawed on the place. Silo 4 years old. Foundation



No. 65. Silos of J. B. Diamond & Sons, Gaithersburg, Montgomery Co.

No. 66. Silo of Robert H. Miller, Spencerville, Montgomery Co.

same as No. 1. Mr. Miller does not believe in cemented bottoms as he thinks they prevent the acid from escaping through the ground. This silo has a shingled roof. ½″ x 6″ boards are placed horizontally on outside of vertically placed studding, with two courses of ½″ x 6″ boards nailed horizontally, with tar paper between, on inside. Three-ply tar paper was used, but two ply is considered ample. 4 doors 2′ 6″ x 3″ feet high. The horizontal covering on the outside continues around between the four doors, thus forming hoops which retain a symmetrical form and adds strength to the silo. Eight penny cut nails were used in construction. Silo is painted red. Silage is stamped around the edges when filling and a saucer shape is maintained until filled. Bottom



Cross-section, Showing Construction of Silo No. 66.

board on outside is left off to allow air to circulate, and afford a place to remove the silage which has blown between studding. Note the increased width of studs at each side of doors which forms the chute for throwing the silage from the silo to the stable. See sketch and photograph No. 66.

Material used in constructing silo:

12 Perch stone.
Studding required:
68 P. 2″ x 4″ x 16′ Virginia pine.
4 P. 2″ x 6″ x 16′ " "
4 P. 2″ x 8″ x 16′ " "
4 P. 2″ x 10″ x 16′ " "
4 P. 3″ x 12″ x 16′ " "

1 P. 1″ x 12″ x 16′ for splicing studding.
1 P. 1″ x 10″ x 16′ " " "
1 P. 1″ x 8″ x 16′ " " "
1 P. 1″ x 6″ x 16′ " " "
9 P. 1″ x 4″ x 16′ " " "
600 P. ½″ x 6″ x 16′ green oak.
1500 sq. ft. 3-ply tar paper.

Cut splices 4 feet long and nail one piece on each side.

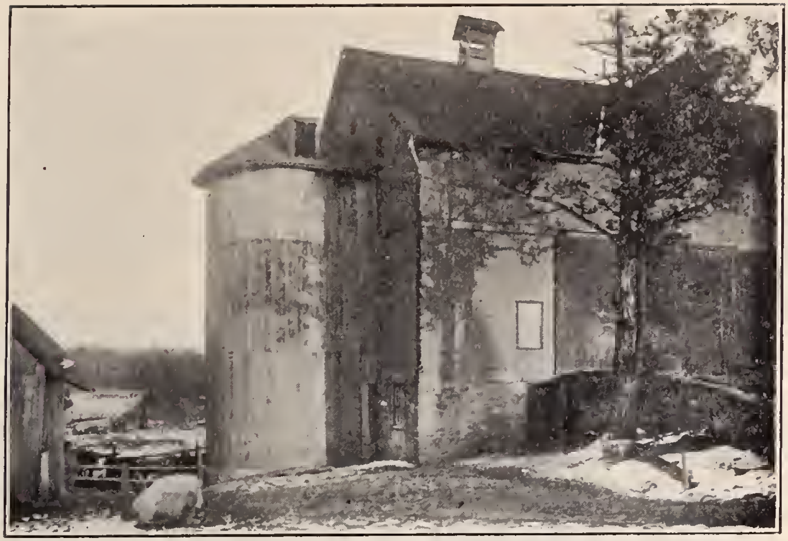
67. Silo of Dr. Augustus Stabler, Brighton, Montgomery Co. Home-made, same style as No. 66. Size 16′ x 35′. Four doors 2′ x 2′. Ladder straddles door. Silo 7 years old. See notes on No. 66. See photograph No. 67 which shows method of construction at the top where outside sheathing has not been put on.

68. Silos of Mr. P. T. Stabler, Sandy Spring, Montgomery Co. No. 1, stave silo, 16′ x 32′. Three years old. Hoops are made of three pieces of oak ½″ x 4″ at top, ½″ x 6″ at bottom. Constructed according to design No. 51, G. E. Shelly. These hoops are put in a pile on the foundation and scantlings are put on the outside the desired height of the silo. The hoops are hoisted one at a time and nailed to the scantlings, which are 2″ x 4″ placed 2 feet apart. When these hoops are placed 2 feet apart, nail the ⅞″ Georgia flooring vertically to the hoops on the inside. After the inside has been well nailed the scantlings can be removed, and the outside vertically covered with 1″ x 6″ chestnut, or other material which will prevent the weather from decaying the studding and lining. Use two boards 16 feet long, vertically; next place

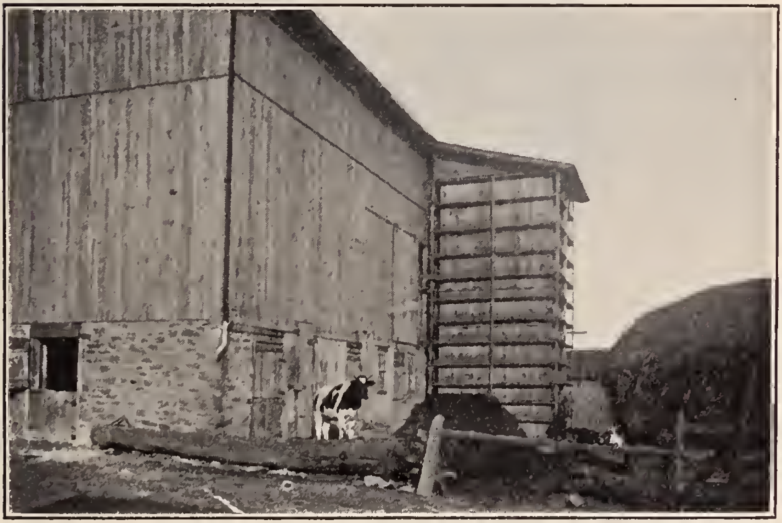
an 8 foot, 16 foot, and 8 foot, then use two 16 feet boards, and so on until the inside is finished, then proceed to do the same on outside. There are 6 doors 2 feet square. Cost including work and material, $120. See photograph No. 68. No. 2, rectangular silo, 12′ x 12′ x 38′. Frame part 28 feet high and stone portion 10 feet deep. This is an older silo than No. 1. This silo is built like that shown in Fig. No. 2, sketch No. 20, lined on inside with ⅞″ yellow pine flooring. There is no vertical covering on outside of horizontal frame, it being exposed to the weather. The frame work, or square hoops, are made of 2″ x 10″, the lining being nailed to the 2-inch side. The corners of this silo are round, a 2 feet radius being used. The 10′ of masonry was placed under this silo after it was built to increase its capacity.

No. 67. Silo of Dr. Augustus Stabler, Brighton, Montgomery Co.

This silo was first lined on inside vertically with 1″ x 6″ rough boards. Tar paper was then applied, and 1″ x 6″ rough boards nailed vertically, 3 inches in advance, making 3-inch laps. On this was nailed the ⅞″ yellow pine flooring, previously mentioned, thus making three layers of boards with one layer of tar paper between. This style silo keeps silage well, silage having remained in this silo two years and was in good condition when fed. See photograph No. 68a.



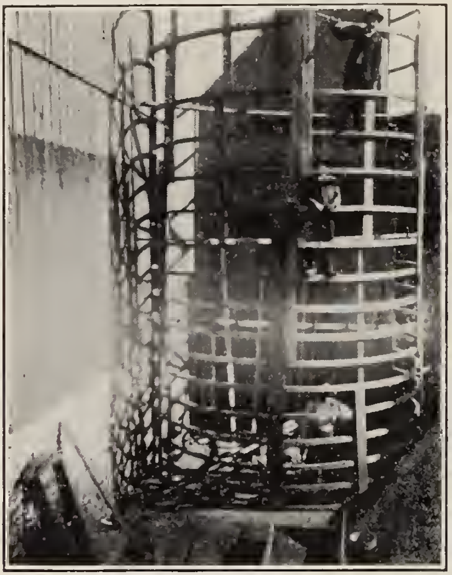
No. 68. Silo of P. T. Stabler, Ashton, Montgomery Co.



No. 68a. Silo of P. T. Stabler, Ashton, Montgomery Co.

69. Silo on farm of Mr. Wm. L. Amoss, Benson, Harford Co. Homemade, wood hoop or Gould type, with vertical lining of tongue and grooved flooring. Size 15′ x 30′. Foundation, cement, for construction see No. 3. Mr. Amoss describes the construction as follows:

The extra heavy Georgia pine flooring is nailed to 18 hoops made as previously mentioned in design No. 51, or they can be made on a form of two pieces of 4″ x 4″ x 14′8″ oak, half lapped in center, this cross is placed on a level piece of ground and boards 1″ x 6″ placed edge up are used as intermediates, the ends of which touch the desired diameter. Stakes are driven on the sides of the boards to keep them in place, about 3 boards between each quarter, thus making a wheel without a fellow. The green white oak strips are bent around this form until four layers have been nailed together, thus making a hoop 2″ x 3″ x 15′ outside diameter. For construction see No. 68. At the base these hoops are spaced 1′0″; in the middle 1′3″; at the top 3′0″. The scaffolding which is used to raise the hoops in place must be well secured and braced.



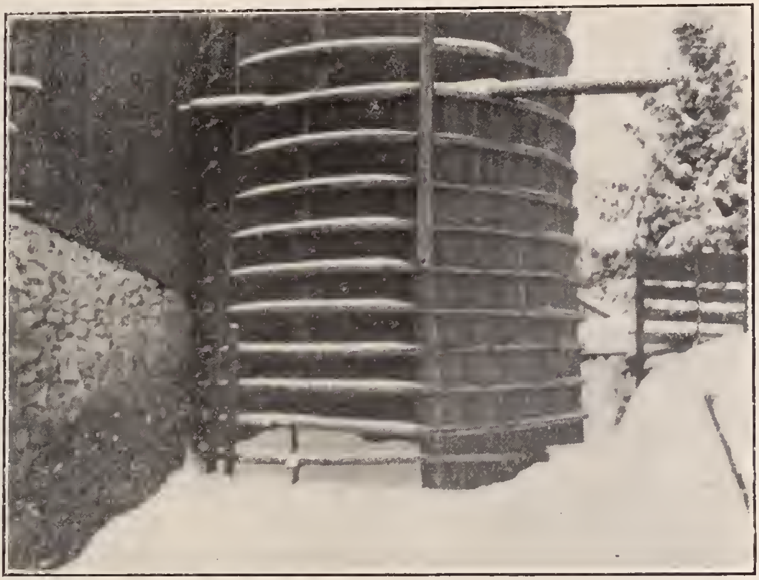
No. 69. Showing Hoops and Method of Framing and Constructing Silo 69a.

The opening for the doors is 8 feet from the top and 4 feet from the bottom.

Be sure and break the joints on the hoops and only one joint at a place.

The doors and frame work were furnished by the Economy Co., Frederick, Maryland.

All the work was done by farm labor directed by the farm manager. The silo was constructed in the summer and winter, working at convenient times. Photograph No. 69 was taken in the summer and photograph No. 69a was taken in the winter. No roof has been placed upon it and none is thought necessary.



No. 69a. Silo on farm of Wm. L. Amoss, Benson, Md.

This silo was filled last season and kept silage satisfactorily. No cracks appear in it through the summer months and it is as rigid as when built. Should another silo be built it would be a duplicate of the first as it has cost much less than the commercial silos, has not required any attention on account of shrinkage or expansion of iron hoops. See photographs No. 69 and 69a.

70. Silos at the Experiment Station. There are at the Experiment Station at present 3 silos. One built of Georgia pine (not tongue and grooved) lumber purchased in the local lumber yard, and two Kalama-

zoo Redwood silos, tongue and grooved. All of these silos are 12′ x 30′ and have iron hoops. It is contemplated building a reinforced cement silo.

Ten other farms were visited and notes were taken on the silos on them; but as they showed nothing different from those already described they have not been included.

A NEW ROUND SILO AS DESCRIBED BY JOHN GOULD IN HOARDS DAIRYMAN.

This plan does away with thick staves and combines in their place the single inch flooring of Georgia pine that has come to be recognized as the best lumber with which to line up a silo, because of its non-shrinkable character.

The foundation of this new silo is in its wooden hoops, made out of half-inch by six-inch-wide elm lumber sprung around a form, and built up with well lapped joints, using a trifle longer nail each time around, until this hoop has a thickness, for the three bottom hoops, of five layers. This calls for 60 ft. of lumber for each hoop, as the remaining five top hoops only need to have four "lifts" each, less than 476 feet of lumber will be needed, and 20 lbs. of 6 and 8d. nails. The hoops are easily and quickly made, and a builder estimates that their cost should not exceed $1.25 each, which would be somewhat less than the $36.00 estimated for iron hoops and lugs. A three cornered frame is erected at the exact outside diameter of the silo, and the hoops placed into position and fastened.

The lining of the silo is then put on, and should be of one inch by three inch wide, matched Georgia pine flooring, and put on and nailed to the hoops the same as flooring. When the lining is on within twenty inches of the starting, stop and cut in 2 x 4 studding up and down between the hoops on each side of the door, for door stays and jambs, and take the remaining flooring and make the doors; cutting them into "joints" on the outside of the hoop.

Then well paint the silo and hoops on the outside, and if the silo is to be on the outside of the barn, it can be cheaply covered by stripping up and down on the outside with tarred paper, and covering with cheap up and down siding, which in reality gives two air spaces, and will be a reasonable protection against the frost.

This silo is one of great rigidity. Its lining does not shrink out of place any more than in a square walled silo, and its hoops are exactly so long and so short every day in the year. The material required would be about 400 feet of elm, or springy ash lumber; 1300 feet Georgia pine flooring, a keg of 8d nails. A builder estimates $20.00 worth of labor for constructing.

The roof and foundation is the same as any ready made silo, and as the man may select, and the outside covering would be governed by the owner's wishes; or it might go without siding, the same as any tub silo. If protected from the weather, the "life" of wooden hoops would be for years, and if at any time the inside lining of the silo became "dozy," it could be stripped up with tarred paper, and a thin flooring put on over, which would make it a serviceable silo again for several years at small cost.

CONCRETE SILOS.

When all things are considered the reinforced concrete silo is probably the best and most economical one that can be built, They have not been adopted in this state but are much in favor in many sections in the Western States as is evidenced by articles and advertisements in papers. Concrete silos should be round and of the same general dimensions as has been found best in the construction of wood silos. They may be built of hollow curved blocks made especially for this purpose, or solid reinforced walls may be used. The latter method of construction would probably be the cheaper and more durable and satisfactory.

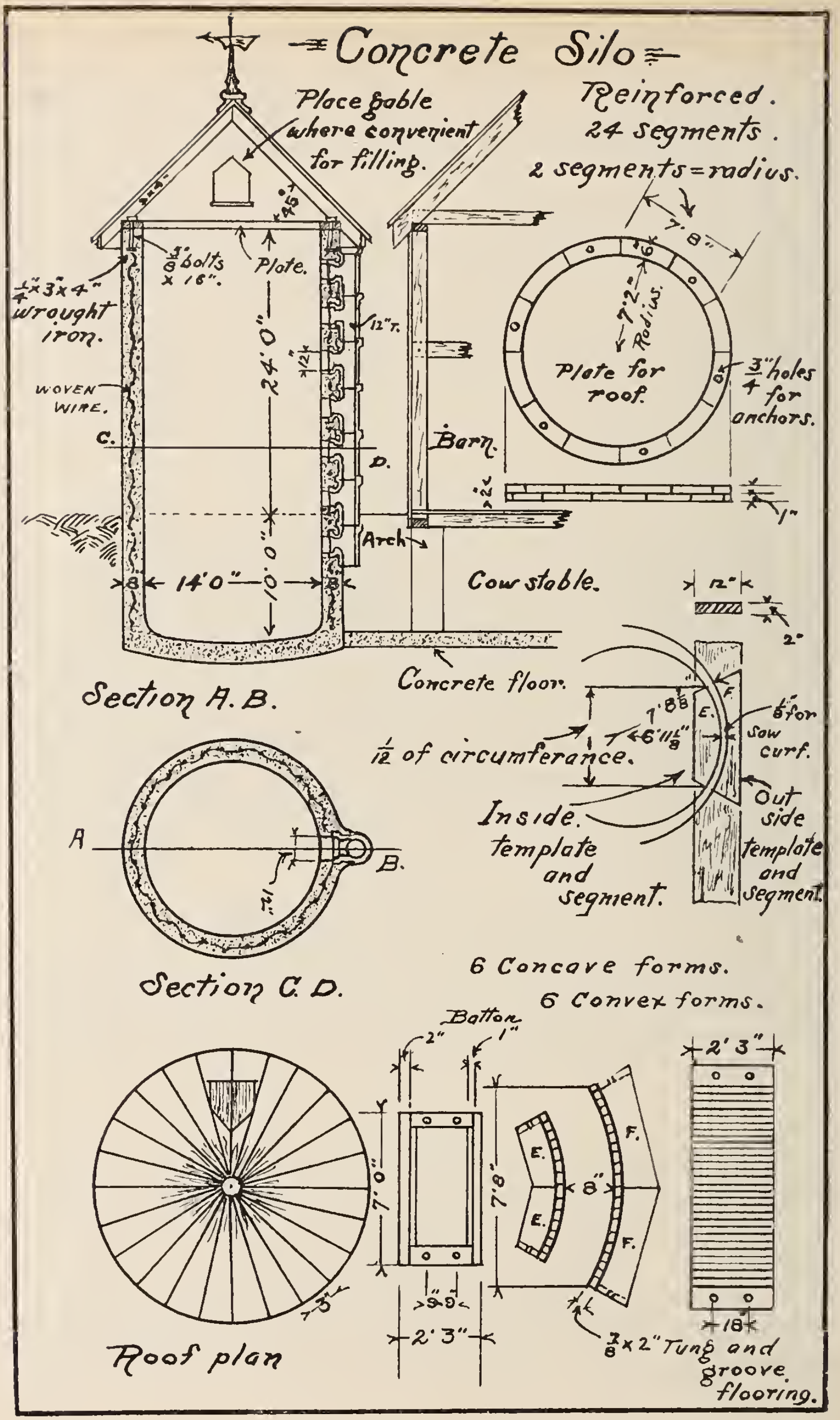
Figures 70 and 71 give drawings showing the construction of concrete silos and method of making forms.

REINFORCED CONCRETE SILO.

The first step in the construction of this kind of a silo is the foundation or footings. This part should be made about the same as for wood silos, except that it might be well to have it a little deeper and stronger so as to carry a greater weight.

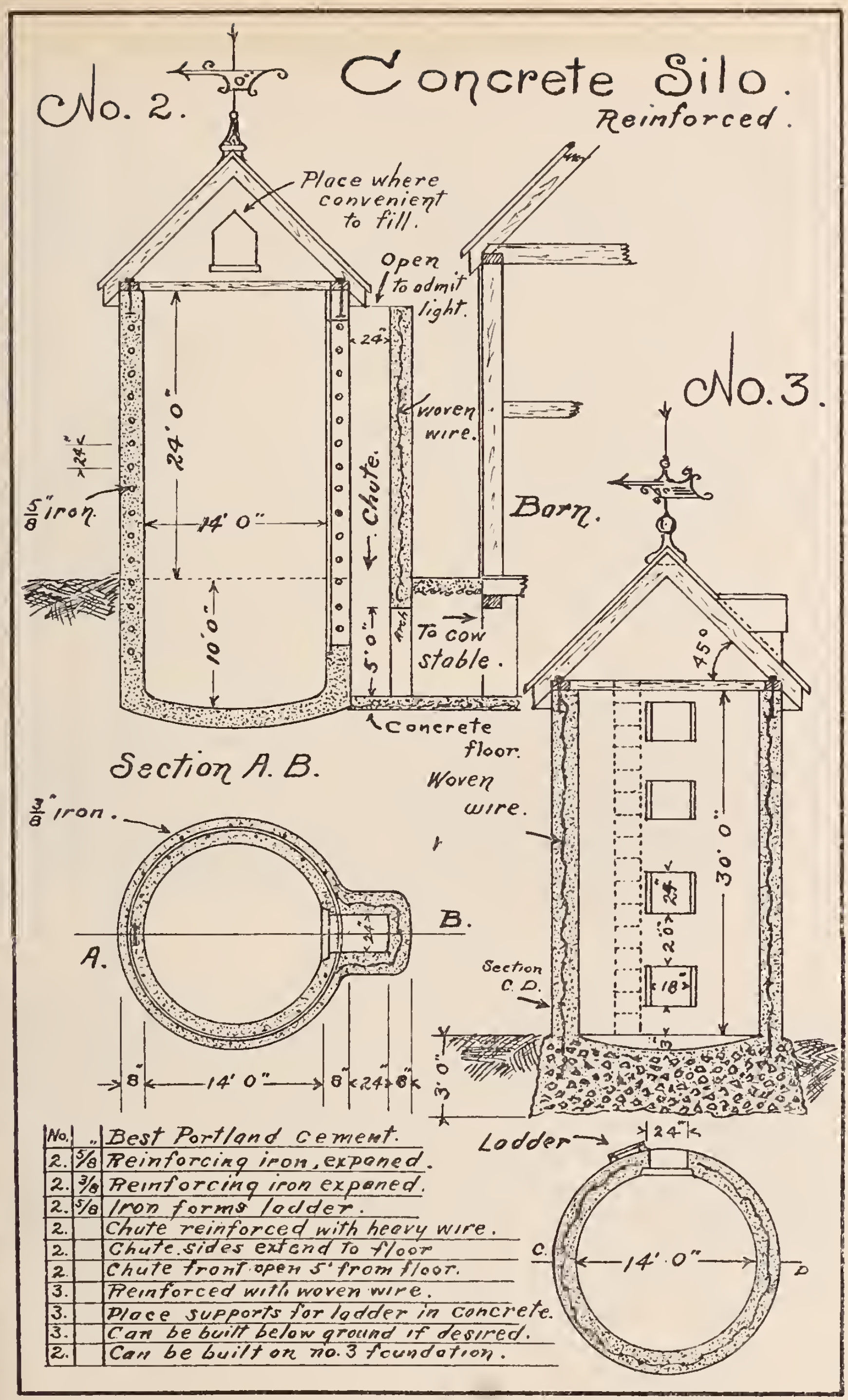
THE FORM.

In making a solid reinforced concrete wall it is necessary to have a form. The form may be constructed in various ways, but the best forms are those built in sections and bolted together as they are more convenient to move. A properly built form should give a smooth surface. The ribs, or templet, of the form can be made on the same general plan as those for a well curbing, and they may be cut into sections afterward, or built in sections as most convenient. It would require



H. L. CRISP. RELAY MO.

No. 70. Showing Construction of Concrete Silo.



No.	„	Best Portland cement.
2.	5/8	Reinforcing iron, expaned.
2.	3/8	Reinforcing iron expaned.
2.	5/8	Iron forms ladder.
2.		Chute reinforced with heavy wire.
2.		Chute sides extend to floor
2.		Chute front open 5' from floor.
3.		Reinforced with woven wire.
3.		Place supports for ladder in concrete.
3.		Can be built below ground if desired.
2.		Can be built on no. 3 foundation.

H.L CRISP RELAY MD

No. 71. Showing Section of Concrete Silos.

two set of ribs, or templets, for the forms. One set should be concave and have the inside of the rib of a circumference equal to the outside of the silo. The other set should be convex, have the outside of the rib of a circumference equal to the inside of the silo. The ribs can be made of any kind of material but they should be at least two inches thick so as to be strong and give a ridged form. Flooring, two inches wide is good material to nail to these ribs to complete the form.

Fig. 70 shows drawings of a concrete silo and the method of constructing a convex and concave templet one-twelfth the diameter of the silo.

The form should be only 3 feet in height. The form should be moved up two feet each day as that will give as great a depth of concrete as should be filled at one time and this will allow twelve inches of the form to rest against the concrete previously placed. The forms for Nos. 2 and 3, Fig. 71, should be built same as in Fig. 70 making allowance for the changes in design. For No. 2 the sections should meet in the center of the chute on the outside so that it can be readily removed. In No. 3, Fig. 71, a frame should be provided for making the cavity for the doors.

The forms should always be carefully and firmly set so as to make the silo plumb and true, and it is especially desirable to have a smooth surface on the inside. The ribs of the forms may be made wide enough to serve as scaffolding for the workmen.

These forms will last for a number of silos, so it would be well for the farmers of a neighborhood to coöperate in making them so that all could avail of their use and thus reduce the expense.

REINFORCING.

There are many different kinds of steel on the market for use in reinforcing concrete. Old iron can be utilized for this work. Extra heavy woven wire fencing has proven very economical and satisfactory to those who have constructed a number of concrete silos. The two ends of the wires should be securely fastened together so as to give a complete frame work. In No. 2, Fig. 71, ⅝ in. square twisted reinforcing iron placed 24 inches apart is designated. These irons also form the ladder. The vertical reinforcing is of ⅜″ twisted square iron cut in 4 ft. lengths and placed 12 inches apart.

THICKNESS OF WALLS.

The walls of the silo should be from 4 to 8 inches thick, depending upon the size of the structure. An experienced builder of concrete silos in Minnesota recommends a 4-inch wall for a silo 16 feet in diameter and 24 feet high, and in practice has found that thickness sufficient.

MATERIAL.

In constructing a concrete silo nothing but first-class Portland cement, sand and gravel, or crushed stone, should be used.

The Portland cement should be No. 1 and fresh.

Sand must be clean, sharp, and free from loam and foreign matter.

Crushed stone or gravel must be clean, hard material and not larger than will pass through a 2-inch mesh, and should contain nothing smaller than ¼-inch.

The concrete should be mixed in the following proportion:

One part Portland cement.
Two parts sand.
Four parts gravel or stone.

Mix sand and cement dry, turning it four or five times to insure a thorough mixture. Then add enough water to make a thin mortar, the consistency of brick mortar or plaster. Then add the gravel or stone, mix four or five times, then dump into the forms at once and thoroughly work and tamp with rod or pole so that the concrete sets firmly around the reinforcing and against the forms. Concrete should be used within thirty minutes of the time it is mixed.

DOORS AND CHUTE.

Doors and chute in the silo may be made after any of the plans suggested by the drawings in Figs. 70 and 71. In Fig. 70 the chute is made by using twelve-inch terra cotta pipe tiles. The center inlet being cemented in the silo when constructed. One of the concave forms will have to be recessed enough to allow the tee to be placed in position. A form of wood will be needed to suit the diameter of the tee and long enough to reach the inside form of the silo. This form will be placed in position in the socket end of the tee before the inside form is placed. This will form a delivery cavity to the opening of the tee. Fig. 71 shows a concrete chute with a continuous door to be closed by white pine sectional doors, and also a silo with doors 3 feet apart.

LADDERS.

In Fig. 71 the reinforcing iron forms the ladder to the silo with the continuous door, and iron staples should be inserted in the concrete to form the ladder in the silo with the intermittent doors. The silo with the terra cotta chute shown in Fig. 70 should be supplied with an iron ladder on the outside to the door in the roof and sockets should be placed in the inside wall for screwing in a hand hold ladder. These could be placed in position as the silage is removed, and taken out as the silo is filled.

The estimates in the papers place the cost of a reinforced concrete silo, 16 feet in diameter and 24 feet high, at $150.00 to $200.00.

This kind of silo will not rot and should be stronger at the end of five or six years than when built.

A very good concrete silo is described on page 78 in the book issued by the Atlas Portland Cement Company, 30 Broad St., New York, N. Y. entitled "Concrete Construction about the Home and on the Farm." This book is also valuable for the general information given on the use of cement. Farmers Bulletin No. 235, published by the U. S. Department of Agriculture also gives valuable general information on the use of cement.

LITERATURE.

On Silos, U. S. Department of Agriculture, Farmers Bulletins Nos. 32, 103, 190 and 292.

On Silage, U. S. Department of Agriculture, Farmers Bulletins Nos. 32, 56, 103, 124, 133, 165, 222, 267 and 309.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 130 AUGUST, 1908

NURSERIES AND NURSERY INSPECTION

By T. B. Symons, J. B. S. Norton and C. P. Close.

INTRODUCTION.

The United States Census for 1900 states that there are 4609 acres devoted to the nursery and plant growing business in Maryland with about one and a half millions of dollars capital invested in the business. The annual sales of these nurseries amounts to about $480,000.

The ability to control San José scale and other insects and also most plant diseases by spraying has restored confidence as to the future profitableness of commercial orcharding; the increased interest in beautifying and developing the suburban homes during the past years as a result of the very general prosperity of the country and the extension of electric railroads into the rural districts; the improvement and extension of the public parks around the towns and cities; and the establishment of school gardens and encouragement of home gardening among the children; all have contributed together with improved shipping facilities to make a largely increased demand for all classes of nursery plants, both the commercially useful and the ornamental.

Maryland nurserymen have met this increased demand, and as a result this industry has grown rapidly in area and some in numbers during the past eight years and at present has bright prospects for still further development in the future. Today Maryland has some nurseries which rank amongst the largest in the United States.

The system of nursery and orchard inspection inaugurated in Maryland in 1898 has done much toward developing the nursery business and inspiring confidence in their patrons. With an idea of still furthering this mutual relationship and interest this Bulletin has been prepared so as to place in the hands of all interested parties detailed information as to general methods of growing nursery stock and controlling insects and plant diseases, and the methods of inspection and certification which are followed not only in Maryland but in other states, together with a summary of the laws which govern inter-state shipments.

GENERAL HORTICULTURAL POSSIBILITIES.

There is such a wide range of soil, slopes, elevations, influence by proximity to large bodies of water, shipping facilities by rail and water, and general conditions, that the horticultural possibilities of this state are surpassed by very few of the states in the Union. The Eastern Shore and Southern Maryland are especially adapted to the growing of summer apples, peaches, pears, plums, small fruits and nuts. The north central portion produces these crops abundantly also, and is especially adapted to the production of winter apples. The western counties, being more or less mountainous and rugged, with cool bracing summer weather and extremely low winter temperature, are especially suited to the growing of the hardiest winter apples and pears.

It would be difficult to find well drained soil in Maryland that could not be made profitable in producing some kind of fruit.

SELECTION AND CARE OF A NURSERY.

In selecting a location for the nursery there are several vital points to be considered, such as convenient shipping facilities, supply of labor, moderate winter climate, freedom from disease and insect pests, ease of securing packing material, price of land per acre and the kind of soil. The more favorable the location with respect to these points the more profitable and satisfactory will be the results.

During recent years the uncertainty and unreliability of laborers have been the greatest annoyance in many parts of the state. The problem, however, is more or less local and must be solved locally. A mild winter climate is desirable for doing a great deal of work in preparation for spring shipments before the rush of spring work is on. If nursery stock is to be shipped to the South it may be got off and out of the way early, while stock for northern shipment can usually be held dormant until it may be started north.

Packing material is a considerable item in nursery operations, and a great saving is made by locating where moss, old straw, strawy horse manure, marsh hay or fine excelsior and cheap lumber, may be readily obtained.

SOIL AND CULTURE METHODS.

The ideal soil for nursery work is rich, sandy loam with clay subsoil. This can be worked early in spring or after a rain without danger of puddling and baking. It makes a most favorable home for the roots and responds quickly to the use of fertilizer.

If a rather thin sand must be used, it may be built up by the liberal use of stable manure, crimson clover, cowpeas and commercial fertilizers. It must be remembered that a crop of nursery stock is especially exhausting to the soil and at least as much fertility should be added as the crop of trees removes.

Heavy soils like clay loams may be successfully used, but a great deal more care is necessary to successfully handle them. If plowed when too wet they become puddled and baked, and if plowed when too dry they become lumpy. The nurseryman must work out this problem on his own land.

Before the seeds, root grafts or seedlings are planted, the ground should be most thoroughly prepared, putting it in the best possible condition. This thorough preparation saves work later and produces better growth of trees. Clean, shallow and frequent cultivation and destruction of all weeds, are essential. About the first of August the last cultivation should occur and then crimson clover seed, 15 or 20 pounds per acre, should be sown for a cover crop during the winter providing this system can be made practicable. Even though the trees are dug in the fall the crimson clover will not be used in vain, because some will be spared to protect the ground and add fertility to it. There will be some difficulty in cultivating out the clover plants between the rows in the spring, but the fertilizing value of the clover will well repay the extra labor necessary. Cultivation and clover may well be made the watch words in handling the soil.

ISOLATION FROM SCALE AND YELLOWS.

Aside from the primary points in the location of a nursery, viz: the quality of soil and transportation facilities, the nurseryman should consider the prevalence of the San José scale and peach yellows in any particular district that he may have selected. When the scale has become well established in a nursery it requires heroic action and treatment, which entails severe losses in preventing its spread. The officers of the State Horticulture Department will do all in their power to cause effective treatment of infested orchards in the vicinity of a nursery, for in no other instance will negligence on the part of growers cause so much trouble and financial loss. Furthermore, even if adjoining orchard trees are effectively treated, their existence may be called a nuisance to the nursery, for it apparently is impossible to eradicate the scale on such trees, and accordingly they serve as a continual menace to the nurseryman. While seldom has an authenticated case of yellows been detected in the nurseries of Maryland, nevertheless, it is of vast importance that nurseries be isolated as much as possible from infected trees, likewise with this disease the utmost efforts of the department are employed to cause to be destroyed all infected trees in the neighborhood of nurseries. It is therefore apparent that the presence or absence of this insect and disease in any locality should be considered as of fundamental importance in determining the location of a nursery.

IMPORTANCE OF SELECTING BUDS AND CIONS.

The selection of buds and cions is the most important item connected with the growing of nursery stock. What does it matter how large and strong, healthy and symmetrical a tree is if it is a poor strain of the variety. That there are excellent, good and poor strains of any established variety of fruit, it requires only fairly good eyesight to prove while passing through an orchard. Some trees are heavy and quite regular bearers of fine, large, highly colored fruit, while others are indifferent bearers of small light colored fruit. Since in nature the tendency is for the progeny to resemble its parent, it is only good common sense to follow the practice of taking buds and cions from trees known to be superior types of the variety. Thus a choice strain of the variety may be secured. Such a strain is often called "pedigree" stock, and it may or may not merit the name.

Fruit growers should understand the advantage of procuring trees thus propagated, and also understand that it entails added expense to the nurseryman to produce such trees and he must necessarily receive a higher price for them than for ordinary trees. The fruit grower should willingly pay the extra price, knowing that it is the best investment he can possibly make in nursery stock.

Since it is entirely impossible for the nurseryman to obtain enough buds and cions for his purpose from desirable bearing trees every year, the practice of using buds and cions from nursery trees of selected strains must necessarily be followed for a year or two at a time, but this should be done as little as possible and bearing trees should be depended on for budding and grafting wood every second year.

The old practice of propagating year after year from nursery trees is unsatisfactory and unreliable and should be condemned. Nurserymen often continue propagating varieties for years in this way without ever seeing the fruit and do not know whether or not they have the variety true to name. As soon as the fruit growers demand better bred stock and are willing to pay for it, the old practice is doomed and the sooner this occurs the better it will be for the industry of fruit growing.

The best method of all for the fruit grower if he depends upon purchasing his trees, is for him to select the budding and grafting wood, send it to the nurseryman, and employ the nurseryman to propagate the trees. Thus the fruit grower does the best possible thing for himself and for the fruit growing industry.

GROWING LOW HEADED TREES.

Until within the past few years everybody who grew fruit trees wanted great, tall, "long-legged" ones, so that a team might be driven beneath the lowest limbs. Most of the Eastern fruit growers still live in the past in this respect. In the Far West the warm sun of mild winter days caused sun scald on the tall tree trunks and the fruit growers learned that a low headed tree shaded the short trunk enough to protect it and the practice of growing low headed trees followed. The East is slow to adopt this improved method, but it is gaining ground.

Compared with high headed trees the low headed ones have the advantage of being easier to prune, spray, graft or bud, gather fruit from, and are as easy to cultivate. Thus a saving in expense in caring for the trees is made. Falling fruit is not injured as it is when falling from a high headed tree.

Nurserymen ought to take the lead in advocating low headed trees, and those who propagate, advertise and push the sale of such trees will reap the reward. A nursery tree should have only those limbs within one foot of the ground removed instead of being mutilated and "beanpoled" four feet from the ground. If the tree remains in the nursery the second year the "leader" should be topped at about two and one-half feet and the side branches be cut back to perhaps four inches; this is the proper way to form foundation branches for apple, pear and plum trees. With peach trees which are always dug when one year old or less, the side branches should never be taken off in the nursery. They should be left for the fruit grower to develop into low headed trees.

CONTROL OF INJURIOUS INSECTS IN A NURSERY.

Accompanying the greatly increased plantings of nursery stock and the introduction into the East of the notorious San José scale, insect control in the nursery has assumed great importance. Negligence on the part of nurserymen in this important aspect of their business will shortly and easily bring about failure. Even with the aid of state inspection of nurseries and many investigations for the control of those pests most harmful to them, the nurserymen have suffered great losses in their efforts to produce clean, healthy stock. The importance of controlling insects and diseases has led many nurserymen to employ competent men whose duty it is to superintend this phase of the work. This procedure can not be too emphatically urged in all large nurseries. Not alone should there be a man whose duty it is to watch the nursery throughout the growing season for the first appearance of insect attack, but he should be assisted by a corps of men who have had experience in spraying and other treatments employed for insect control, whom he can place on any outbreak that should occur. The size of the force will be dependent upon the size of nursery. Nurseries will find the money expended for labor in this direction, intelligently directed, very profitable. Too much stress cannot be placed upon the importance of having such work properly directed, for even in applying insecticides much injury can be done if the proper materials and strengths are not employed for each particular insect attack.

Too much attention cannot be paid to general nursery management in the control or prevention of insect attack. Clean culture methods should be employed. The practice of carrying over the odds and ends of the previous year's stock heeled in the yards or elsewhere, cannot be too strongly condemned. The constant exchange of stock among nurserymen to enable them to fill orders should be conducted with much care. All such stock coming into a nursery should be carefully examined to prevent as far as possible new pests being introduced and established.

Nurserymen should also be careful to see that all fruit or other trees likely to harbor insects in the immediate neighborhood of the nursery are destroyed. When such trees become infested with nursery pests they serve as a constant source of infestation to the growing stock. The nursery and its surroundings should be as free as possible from fruit trees, wild cherry, sumach, hawthorn, osage orange and other hedges.

A detailed description of all nursery pests would be superfluous in this connection, inasmuch as they have appeared in previous Bulletins of this Station. It is only desired to cite briefly here the most common pests with the latest methods of combating them.

SAN JOSÉ SCALE.

The introduction of this pest in the East and its spread into many nurseries has been a source of severe loss to those nurserymen. Many Maryland nurserymen have shared these losses in the destruction of stock infested by this insect.

The enormous number of food plants upon which this insect has been found makes it one of the most difficult pests to eradicate or control in the nursery.

Scale has been found on the following plants in the nursery:—peach, plum, apple, pear, apricot, cherry, quince, almond, hawthorn, osage orange, currant, gooseberry, raspberry, strawberry, grape, rose, spirea, flowering quince, flowering currant, prunus pissardii, cotoneaster, mountain ash, english walnut, black walnut, pecan, persimmon, elm, linden, willows, poplars, cottonwood, maple, catalpa, sumach, lilac and privet.

The control of this pest in the nursery is of necessity quite different from means employed in the orchard. A nurseryman is not supposed to sell a tree that is infested with scale, therefore, when the San José scale is present in the nursery, prompt measures should be employed to prevent its spread. The nursery stock should be gone over carefully row by row and the infested trees dug up at once and destroyed. This work should commence in spring and continue during the summer, as one infested tree in a block in the spring will serve to infest thousands of trees in that and adjoining blocks if allowed to remain throughout the summer. Therefore what is known in nursery parlance as "chasing" scale in the nursery rows by keen eyes is certainly valuable work. After going over an infested block in this manner the trunks of the trees should be then treated with whale oil soap, using two pounds to the gallon of water. This will not only serve to kill any scale on trees that escaped the "chaser's" eye, but it otherwise is a good treatment for the trees as it cleans the bark, thereby improving the general appearance of the stock.

The practise of fumigating all seedling stock, buds, grafts or cuttings used for propagation purposes either from outside sources or from one's own nursery with hydrocyanic acid gas can not be too strongly recommended. Recent experiments have demonstrated that this gas will not injure peach buds during the budding season when properly used even at the normal strength recommended for fumigating nursery trees.

Spraying for this pest regularly during the dormant season should be practiced by nurserymen even if the scale has not been found in the nursery. It is a good preventative and also serves to add vigor to the trees. The lime-sulfur wash is no doubt the most satisfactory remedy for spraying young stock. A discussion of the various washes on the market for scale has appeared in recent bulletins from this Station, and these results will be supplemented from time to time in future issues.

In concluding the discussion on this, no doubt the worst insect pest of the nursery, it is urgently recommended that those nurserymen who have not as yet had trouble from this pest, that they be steadily on their guard for its first appearance and no pains should be spared in taking every precaution in the fumigation of all propagating stock and in spraying with proper solutions, and in employing up-to-date methods in the conduct of the nursery.

To those nurserymen who have in the past experienced losses from the presence of this pest it can only be recommended that they continue the vigorous precautions and methods followed in the past. The nurserymen of this state can rest assured that the officers in charge of the inspection and control of this pest will give them all the support in their power to enable them to keep their premises clean and thus promote their business and protect their patrons.

THE WOOLLY APHIS.

This common and easily recognized pest is known by all nurserymen. Since it affects only apple it is not nearly so serious as the San José scale, yet it often is the cause for the discarding of many hundreds and sometimes thousands of trees. Its principal injury is to the roots of nursery trees although it is often found attacking the branches and foliage.

Practically all nurseries growing apple trees are attacked to a greater or less extent. It is most common on trees planted in new ground. It is best to destroy trees badly attacked with this pest, but where a slight attack is apparent on the branches throughout a block, spraying with a contact insecticide in the form of kerosene emulsion or strong tobacco decoction is usually a very satisfactory treatment.

The control of the pest when attacking the roots of trees is rather difficult, in fact it may be stated that there is not yet a thoroughly practical remedy. In nursery practice it is usual to discard all trees, whose roots have been badly injured by the pest and the fumigation of all trees with hydrocyanic acid gas before shipping usually kills any aphis that may be present and prevents further injury. The abundant use of tobacco dust around nursery trees will serve to prevent the presence and injury from this pest, and as this material has qualities as a fertilizer for the trees it may be profitably used in a nursery subject to woolly aphis. It can either be placed along the rows when the apple seedlings are planted or later when the stock is budded or grafted. Saturating the soil around the roots of apple trees with a dilute solution of kerosene emulsion is recommended by some authorities. This is suggested as especially adapted to old apple trees, but this treatment has not been sufficiently tested to recommend its use in the nursery. Continued experiments are being conducted against this pest in the nursery with a view of securing a more efficient remedy.

THE BLACK PEACH APHIS.

Similar in habits to the woolly aphis of the apple in occurring in both aerial and subterranean forms the black peach aphis differs in being dark in color and lacks the white cottony excretion which envelops the abdomen of the larvae of the woolly aphis.

Injury by this pest in the peach nurseries seems to be on the increase. The injury to peach roots is not so pronounced in causing a knotty appearance as is the case with the woolly aphis of the apple, yet their continued attack by sucking the juices from the roots and also from the foliage devitalizes the trees. Its presence on the roots is often unsuspected, the failure of such trees being attributed to other causes. When this pest has already become established on the roots of trees its control is often quite difficult. Heavy dressings of kainit is recommended as effectual in killing the aphids. Also unleached wood ashes placed along the roots of the trees has proven efficatious, while the free use of tobacco dust applied around the roots after the soil has been removed will be found to be one of the best means of control. Spraying the foliage with kerosene emulsion is usually a satisfactory treatment.

GREEN APHIS OF THE APPLE.

No injury is so common in the nursery as that caused by the several species commonly known as green aphis on apple foliage. The aphis may appear in early spring when the foliage is out and immediately causes the leaves to curl.

Quite often these insects do considerable damage in retarding the growth of nursery trees. Remedies should be applied to control them upon their first appearance. Kerosene emulsion, about 15%, sprayed on the foliage has proven effective in controlling these aphids, but no doubt we have a more satisfactory remedy in the tobacco decoction, known as "Black Leaf." This solution should be used diluted with cold water, one part of Black Leaf to 40 or 50 parts of water. These remedies can be used for all species of aphids found affecting the foliage of decideous trees.

THE OYSTER SHELL SCALE.

This scale insect is commonly found in the nursery attacking lilac bushes, apple, maple and other trees. It is not nearly so injurious as the San José scale inasmuch as there is usually but one generation throughout the year. In contrast to the San José scale this scale insect winters in the egg state, nevertheless, treating infected plants with a caustic wash such as the lime sulfur during the dormant season, will corrode the scale and allow the eggs to be washed out by rain or otherwise destroyed. Treatment with kerosene emulsion, 15%, can be employed about the middle of May when the eggs hatch. This will be found very effective and is advisable when dormant spraying is not practiced.

THE SCURFY SCALE.

Similar in habits to the oyster shell scale, this whitish scale is often found attacking the bark of apple trees in the nursery. It is not a serious pest, however, and can easily be controlled by the same remedies employed for the oyster shell scale.

CATERPILLARS.

The larvæ of several insects may be found at various times during the growing season attacking foliage of various plants in the nursery. Much injury is sometimes occasioned by such pests when allowed to continue their ravages unmolested. In combating such insects, when it is practical to employ an insecticide, some form of an arsenical should be used according to formula given below.

FORMULAS OF COMMON INSECTICIDES.

In combating insect attacks it is of prime importance that the grower be able to distinguish the manner in which the insect does its injury. There are two main divisions, first, insects that do their injury by eating, in combating which it is usual to employ a stomach poison, and secondly, insects which do their injury by sucking the juices of the plants, in which case it is usual to apply contact insecticides, gases, etc.

PARIS GREEN.

Paris green ¼ to ⅓ pound in 50 gallons of water. This well-known arsenical is commonly used in combating biting insects. While there are other arsenicals which are cheaper and possibly their purity can be more depended upon, yet this is a widely known insecticide and it is generally recommended by entomologists. Often it is well to add 4 to 5 pounds of slacked lime to the 50 gallons of water when paris green is used alone, in order to prevent any possible injury to foilage by burning.

Paris green is often combined with bordeaux mixture, a fungicide, in the same proportions as with water. The combination is then a fungicide as well as an insecticide.

ARSENATE OF LEAD.

This arsenical is used by many in preference to paris green as it is less caustic and not so liable to injure foliage and it remains in suspension and adheres to foliage for a longer period. It is usually recommended to be used at any strength, from 1½ to 6 pounds to 50 gallons of water. Recent tests, however, on young peach and plum foliage at 2 pounds to 50 gallons of water would indicate that the use of this strength on these plants should be conducted cautiously, in fact, it is better to use only one pound to the 50 gallons of water.

This product is sold by many manufacturing chemists and its quality is fairly reliable.

GREEN ARSENOID.

This powder is somewhat lighter than paris green and probably superior to it in composition. It also remains in suspension for a longer period. It can be used in the same proportions as paris green.

LIME-SULPHUR WASH.

Fresh stone lime	20 pounds.
Flowers (or flour) of sulphur,	15 pounds.
Water to make	50 gallons.

Boil 20 gallons of water in an iron pot or hog scalder, then add the 20 pounds of lime, also the sulphur, which should have been previously mixed with a little hot water to form a paste. The mass should be cooked vigorously until the sulphur is thoroughly dissolved, and a clear amber colored solution is produced. This usually requires about 30 minutes. Then add sufficient hot or cold water to make 50 gallons and apply warm.

KEROSENE EMULSION.

Kerosene	2 gallons.
Common soap	½ pound.
Water	1 gallon.

Dissolve the soap in boiling water, add the kerosene and emulsify by violent churning. Dilute to the required strength.

PATENT INSECTICIDES.

There are many so-called patent washes on the market. The grower is urged to be careful in employing any new wash. Try it in an experimental way on a small portion of your orchard, nursery or other plants, unless you can secure reliable information as to its effectiveness without injury to the plants.

WHALE OIL SOAP.

As stated previously this soap should be used at the rate of 2 pounds to the gallon of water for treatment against scale in the nursery. During the growing season, it can be applied only to the trunks of trees. During the dormant season it can be sprayed over the whole tree. When used in the latter manner it is best to apply it in early spring just before the buds open.

TOBACCO.

Tobacco is used in many ways as an insecticide. Old tobacco stems are often steeped in hot water, a pound of the stems to a gallon or two of water, the solution being used as a spray against aphids. The manufactured product known as "Black Leaf" is no doubt preferable and more satisfactory. It is used at the strength of one part of the solution to 40 or 50 of cold water.

Tobacco dust is a good material to place around the roots of trees when planted to prevent injury from root aphids. A couple of handfuls to the tree is usually sufficient. The burning of tobacco stems in a greenhouse is helpful in destroying several pests.

HYDROCYANIC ACID GAS.

This gas has come into use of late years as an important insecticide. Its use in fumigating nursery trees to prevent the distribution of the José scale has become quite general. It is made by combining the following:

Cyanide of Potassium, 98 per cent	1 ounce.
Sulphuric acid (commercial)	2 ounces.
Water	4 ounces.

This formula will fumigate an enclusure containing 100 cubic feet. Place acid in an earthen jar then add water and cyanide. Be sure to have the room or enclosure air tight, or nearly so. Keep everything closed for at least 30 minutes. This formula will serve to fumigate nursery trees, but in fumigating buds, etc., it should be reduced one third, using $\frac{2}{3}$ of an ounce of cyanide and a corresponding reduction in acid and water. It is a very deadly gas and much care should be exercised in its use.

Often a small box is used for fumigating buds, grafts, etc. When it is desired to fumigate in such small enclosures it is best to send the three dimensions of the box to the Experiment Station and have the amount of materials estimated and the formula prepared for it.

BISULPHIDE OF CARBON.

This liquid is used in destroying stored grain insects and the like, and also some pests under ground, but principally the former. The liquid evaporates very rapidly, the gas being deadly to animal life when confined in it for any length of time. In fumigating grain or other similar material use one to three pounds of the liquid to 100 bushels of grain. The gas is exceedingly explosive; therefore do not allow any light, cigar or pipe around the building when fumigating. It is sometimes injected into the soil around the roots of the plants to destroy certain pests. In such cases a tablespoonful of the liquid injected a short distance from the plant would be sufficient. The gas is heavier than air and consequently it will sink into a pile of grain or down into the earth.

CONTROL OF PLANT DISEASES IN THE NURSERY.

Variations from the ideal in the production of nursery stock due to unfavorable climate, soil, etc., occur from year to year and must be provided for by proper cultural methods. Though unexpected loss often comes from outbreaks of disease, the profit in growing nursery stock is often decreased by fungi and other parasites which are so common that they are not regarded, the early leaf fall or lack of growth being considered normal, when in fact it might have been prevented by spraying. This is particularly the case with the leaf diseases due to parasitic fungi.

LEAF DISEASES.

The importance of the leaves must be recognized, as they are among the most essential parts of the plant. Every particle of material for growth, must be prepared in the leaves before it can be used to increase the diameter or produce new branches or roots on young trees; so that for healthy growth it is necessary to have an abundance of leaves, and the longer they remain on the longer growth can continue. Where the season is short and the annual growth must necessarily be small, this is of all the greater importance; but in this state the leaves may sometimes remain on the trees longer than is desired. However, even here, in many cases the loss of growth is very noticeable, due to the early fall of leaves from the effects of fungous diseases.

It was demonstrated many years ago by experiments conducted by the United States Department of Agriculture in Maryland and New York, that spraying with bordeaux mixture five to seven times during the growing season is a great benefit in preventing the early fall of leaves so common on many varieties of nursery stock. The diseases of this character that are most noticeable are the leaf blight of pear (which, of course, must not be confused with the twig-blight, or fire-blight of pear, mentioned later and due to a different cause), the scab, mildew, leaf-spot, and rust of apple, the mildew and leaf-curl of peach (the leaf-curl, however, occurring only in the early part of the season, and the mildew being bad only on a few varieties, such as Tillitson), the leaf-spot of cherries and plums and the mildew of grapes. Practically all of these could be controlled by proper spraying with bordeaux mixture, and many of our nurserymen put it into practice every year, some of the larger nurserymen keeping a sprayer going nearly all of the time during the summer.

The peach leaf-curl is as a rule not serious in the nursery, and the greatest loss in Maryland nurseries is due to the leaf-blight of pear, which frequently causes the loss of all of the foliage before the middle of August, and the cherry leaf spot which also causes the leaves of the cherries to fall very early in the season. Many of the plums are affected in the same way; the spraying of the plums with bordeaux for the leaf-spot can hardly be advised, however, as many varieties are injured by it. The peach is also very sensitive to this preparation, and if it is used at all outside of the dormant season, must have a great excess of lime; say, three pounds of copper sulphate to eight or nine pounds of lime in fifty gallons of water, but some of the lime and sulphur mixtures can be safely used to better advantage.

The grape mildew is usually very serious, especially on certain delicate varieties, and the death of a great many plants in the nursery is largely due to the loss of strength from the effect of this mildew on the leaves; and the spraying of grape stock would be one of much benefit to the nursery.

NURSERY SANITATION.

Cleanliness in the nursery is one of the most important things in controlling diseases, although the spraying mentioned is not to be neglected. A great many of the diseases found on nursery trees are also found on wild trees which may be growing in the vicinity. The ideal place for a nursery would be away from all woods and orchards, and the hedgerows and fences should be kept clean from all shrubbery liable to carry disease or insects. The leaf diseases which have been mentioned, although perhaps being the cause of loss of growth more than anything else, are comparatively easy to control, when the diseases of the stem are taken into consideration. The black knot of plum is perhaps the worst of these that has to be contended with here although it is uncommon on nursery stock. Old wild-cherry trees carrying knots of this disease as big as a man's body, are often seen standing along the fences in nurseries offering every chance of infection to the young stock. Cedar trees, so common along fences where they grow up naturally from seeds left there by the birds, cause the infection of many varieties of apple with the leaf rust, which comes from the other stage of this fungus in the so-called cedar apples. This leaf rust is difficult to control by spraying, and could be largely prevented by the removal of the cedar trees from the neighborhood.

It is no doubt necessary to have trial orchards in connection with nurseries, but orchards, and especially old worthless trees standing around the nursery, are simply infection points for fungous diseases of different kinds, and always are an indication of lack of care in growing the stock to any person visiting the nursery. A nursery should be entirely removed from all old trees of any kind, since they are likely to be full of fungous diseases and insects, unless especially well cared for. The stock held over by nurserymen, especially the smaller nurserymen, and heeled in near the growing stock, is also a menace of this kind, as it is usually of less vitality and so more liable to be infected early by fungous diseases which may then pass to the young stock.

Where it is not possible to have a nursery away from the woods and orchards, the trees especially to be looked out for and removed are those which are closely related to the cultivated stock, such as wild cherry, plum, hawthorn, crab apple, etc., and those which carry other stages of parasitic fungi, although not related, such as the cedar, which is a host of the apple-rust.

DISEASES OF THE WOOD.

The anthracnose of the raspberry sometimes occurs in the nursery, and although some good can be done by spraying with bordeaux mixture, the better method would be to carefully select healthy stock for propagation, and if the raspberry fields in the nursery became infected, to start other blocks, taking particular care to set with healthy plants, in other parts of the nursery distant from the infected places. The orange-rust of blackberry and raspberry also needs special care to prevent its spreading. It can hardly be treated by spraying, but all the diseased plants should be destroyed, even to the roots, in which the fungus passes the winter.

The twig-blight or fire-blight of apple, quince, and especally pear, needs special treatment. It is most common on trees which have bloomed, since it is more easily introduced by bees through the flowers; but, as is well known, it occurs frequently in nurseries of young trees. It usually appears in the latter part of summer, and although not often abundant enough to cause much loss in the growth of the trees, the nurseryman must look out for it to prevent its further spread and its being carried to his customers' orchards. The blight can best be controlled by cutting out the blighted twigs and branches in the latter part of summer, cutting six to ten inches below the lowest visible marks of the disease on the bark and frequently disinfecting the knife; or, if not abundant, perhaps cutting off the infected trees entirely. It is especially important that pear varieties susceptible to the blight should not be grown near old orchards of apple or pear, where this disease is liable to be present, and especial care must be taken to keep the blight out of the old trees, the many cases in the old bark requiring close search to find them.

Another wood disease is the plum canker, showing as sunken decayed spots, extending through the bark and wood of certain plum varieties. Such trees should be discarded and propagation made from healthy ones.

Peach yellows, while often introduced from the nursery, has been but rarely seen in the young trees. The disease may be present and not show symptoms for some years. It has been demonstrated that this disease is easily propagated by taking buds from diseased peach trees, and even from trees which do not at the time show the disease, but develop it in a few years; and as a rule, nurserymen are careful not to use buds from affected orchards. It is a common practice, also, to use the pits from seedling trees from regions where yellows is not found; particularly from the southern part of the United States, as a means of preventing the disease in nursery trees, but plenty of yellows in natural peach trees has been found as far South as the Tennessee and North Carolina mountains. From the tabulation of reports on thousands of orchard trees, obtained from the different nurseries in Maryland, and in some other states, no particular difference in the number of trees developing yellows from different nurseries has been detected.

ROOT TROUBLES.

The root diseases of trees in the nursery are among the most aggravating forms of unhealthy conditions, especially the crown gall, which has caused much trouble and loss to nurserymen. Recent investigations have shown that a number of distinct troubles have been confused with this name, and that the softer crown gall on certain kinds of trees like peach, and some species of plum, as well as raspberry, although in these cases very injurious, is probably distinct from the disease to which the same name has been applied on apple. This hard, woody gall near the junction of the stem and root of apple stock is not very contagious, however injurious it may be to further growth of the tree. Another form which is best known as hairy root, causes a stunted root system and the development of stiff root branches from the main root, totally distinct from the natural fibrous roots. The affected roots in most cases die, and the further root growth of the tree is supplied by new roots developing above the affected portion.

Unfortunately, there is no very practical means of controlling these diseases in the nursery, although a few years' further investigation may yield something of value. Even if the hard galls do little injury to the apple the affected ones can hardly be called perfect trees, and many observers think that they have seen a decided injury in the orchard from the planting of such trees. The trees affected with the galls are certainly more likely to send up sprouts from the base of the trunk, which is some indication of lack of healthy growth in the main tree. The hairy root, as well as many of the galls, may be avoided by careful selection of seedling stock, which if diseased, shows already the effect in the development of the stiff fiber, or rough bark. Buds or cions from diseased trees are also more apt to develop the disease. Anything but perfectly healthy roots should be thrown out and not used for propagation. Careful wrapping of grafts or budding is a further prevention.

The common crown gall on the peach, plum and raspberry is quite distinct and injurious. It is quite infectious, and ground that has been planted in trees affected with this disease should not be used for some years for the same stock, and great care should be taken in propagating not to communicate the disease with knife or by contact with roots from diseased fields.

PREPARATION OF FUNGICIDES.

BORDEAUX MIXTURE.

Bordeaux mixture is used more than any other substance to prevent plant diseases. It is made of copper sulphate (blue stone) dissolved in water and mixed with stone lime slaked in water. There must be enough lime to combine with all the copper sulphate so that it will not injure foliage, otherwise the proportions may vary considerably for different purposes.

Copper sulphate	3 to 5 pounds.
Lime	5 pounds.
Water	50 gallons.

Dissolve the copper sulphate by immersing in a bag hung in the top of a vessel of water for several hours, and dilute to twenty-five gallons of water, a half barrel can be used to hold it. Slake the lime in a similar vessel and dilute to twenty-five gallons. Pour the two together through a strainer into the sprayer. The bright blue liquid resulting is bordeaux mixture. The lime should be kept stirred, as it settles quickly. The copper sulphate will act on iron and some other metals. Brass or wooden vessels should be used for it. The milk of lime and copper sulphate solution should not be mixed while hot or before diluting. They will keep indefinitely before mixed, but the bordeaux mixture should be used the same day it is made.

Where several barrels of bordeaux mixture are to be used, the use of stock solutions will save much time. These are made by dissolving fifty pounds of copper sulphate in fifty gallons of water in one barrel, and slaking fifty pounds of lime and diluting it with fifty gallons of water in another barrel. Then, for making bordeaux mixture take as many gallons as pounds of each substance desired, dilute and mix as before. Evaporation from the stock solutions must be avoided and they must be thoroughly stirred before using from them. When proper water supply is at hand, the stock barrels, diluting tubs, etc., can be arranged on an elevated platform so the liquid can be passed from one to the other from spigots, and then run in similar manner through hose into the sprayer thus saving much time and greatly facilitating the work.

The properly prepared bordeaux mixture should have a bright sky-blue color. If the lime is poor it may have a greenish cast, and is then liable to injure foliage. It can best be tested by dropping a little solution of yellow prussiate of potash into the mixture. If a reddish brown color results, add lime until the test repeated shows no brown color. It is better to add more lime than enough to combine with the copper sulphate. Bordeaux mixture is an excellent medium in which to apply arsenical insecticides.

Bordeaux mixture for use on peach and plum foliage or other plants liable to injury by the stronger mixture used for most crops, is made in a similar manner by the following formula:

Copper sulphate	3 pounds.
Lime	9 pounds.
Water	50 gallons.

One must be sure the lime is good, as with this excess of lime, the before-mentioned test would not be practicable.

SULPHUR.

Sulphur is an excellent fungicide. It is used in the form of "flowers" or "flour" of sulphur. The former is usually better for applying in the dust form for mildews, asparagus rust, etc. The fumes from burned sulphur are used in disinfecting buildings, but are very destructive to live plants. Whitewash may be given disinfecting properties by mixing sulphur with it. The lime sulphur wash used for dormant treatment for insects acts at the same time as a fungicide; but the sulphides it contains are injurious to foliage.

A lime and sulphur mixture has recently been used with considerable success as a summer spray for diseases of foliage and fruit. This will probably prove a very satisfactory treatment for nursery stock. This mixture is not cooked sufficiently to form sulphides in injurious quantities, but the sulphur is held by the lime and acts slowly in keeping down diseases. The usual method is to slake 10 to 15 pounds of lime, stirring in 5 to 10 pounds of sulphur while it is hot and dilute without other heating with water to make 50 gallons. The mixture may be cooked some by the slaking lime, but should not be heated enough to give more than a faint yellow color to the liquid before it is diluted.

SPRAYING OUTFITS.

For a general discussion of spray pumps and apparatus for use in orchards, etc., the reader is referred to Bulletin 115 of this Station which can be had for the asking.

For spraying in a nursery, special apparatus or rather special mechanical arrangements are necessary for satisfactory work. The barrel sprayer is most commonly used in nurseries. The barrel and pump should be mounted on a special two-wheel rig of sufficient height to permit it to go over the tops of nursery trees without injury. Some rigs are so made that the rows of trees pass between a high arch in the axle. The pump may be worked by hand or geared to the wheels similar to many special potato row sprayers. In fact the special row sprayers can be used with advantage in the nursery when the stock is small. These sprayers are fitted to spray two or four rows of plants or stock. When the nursery stock grows large the rig referred to above usually sprays two rows; both are one-horse rigs.

Power sprayers other than the geared sprayers can be sometimes used in nurseries to advantage, especially when the stock is small, but the employment of such apparatus will usually depend on the quantity of stock to be treated.

The conditions under which spraying is done are so varied that only general recommendations can be made, and each individual will have to select that which his judgment dictates is best adapted to his conditions.

SPRAY PUMP MANUFACTURERS.

The catalogs of most firms are well illustrated, and it is wise for those anticipating purchasing a pump to secure these from many firms and select the one suited to his work. To this end the following list of manufacturers and dealers in pumps and supplies is given:

Griffith & Turner Co., Baltimore, Md.
Gould's Mfg. Co., Seneca Falls, N. Y.
The Deming Co., Salem, Ohio.
Morril & Morley, Benton Harbor, Mich.
Field Force Pump Co., Elmira, N. Y.
Myers Pump Co., Ashland, Ohio.
Geo. H. Stahl, Quincy, Ill.
Spray Motor Co., Buffalo, N. Y.
L. H. Orndorff, 203 7th Street, Washington, D. C.
F. W. Bolgiano & Co., 935 B Street, Washington, D. C.
Brant Mfg. Co., Chisago Falls, Wis.

MARKETING OF NURSERY STOCK.

Too much importance cannot be assigned to this phase of the nurseryman's business. Often his success or failure will depend upon the proper handling and distribution of the stock. Furthermore, the handling of the stock during the digging and packing season affords an excellent opportunity for mixing varieties unless systematic methods are employed in the conduct of the work. Nothing will bring a nurseryman into disrepute more readily than for his customers to be disappointed in the varieties they had selected.

To meet the demands of orchardists who invariably request that trees be shipped in early fall, when wished for fall planting, the nurserymen have gradually commenced digging earlier and earlier in the fall, until now it is common practice to strip nursery trees of their foliage, and about the last of September or early in October they start digging for early shipments. Depending upon the season, this practice no doubt tends to weaken the trees to some extent. Nursery trees should not be dug until they are assuming a dormant state.

There are various methods of digging, and it is not for us to advise which is preferable, as the nurserymen must employ that which is most convenient to his circumstances. The use of the "tree digger" is no doubt very desirable, as after it has been drawn under the trees they are much easier removed. Care should be exercised in its use in order that an undue amount of roots are not mutilated.

During the digging period in a large nursery, the foreman and men who attend to spraying and other such work in the nursery, should be at the digging field and all trees should be handled by this force before being carried to the packing house. No matter how carefully a nursery is conducted, there will be many trees in the nursery row which are unsalable. Woolly aphis or crown gall may be present on the roots or other injuries apparent which will be sufficient cause to discard trees. They will then be destroyed in the field, and there will be no risk of their escaping notice in the rush of getting out shipments at the packing house. This procedure is insisted upon if the presence of San José scale is suspicioned.

Again during this operation of digging too much stress can not be laid on the importance of keeping the roots of the trees out of the burning sun. There is no doubt, in the writers' opinion, that many healthy, strong trees are thus injured by their roots being exposed to the air and sun before they reach the grower's hands. Not only should this be prevented in the field or on the wagon, but also in the packing house. The wind will dry the roots of trees even if they are in the shade. The writers' fully believe that injury sometimes charged to fumigation is invariably caused by carelessness either on the part of nurserymen or orchardists in allowing the roots of trees to be unduly exposed.

The character of packing shed and the manner of handling the stock at this stage in the conduct of the nursery business is a subject which we are not prepared to discuss or offer suggestions concerning, as the financial status of the nurseryman will largely determine the conveniences which he employs for handling the stock. For large nurseries the packing house should either be located near the railroad track or a switch run to it. It should be so arranged that cars can be loaded direct from the packing house. The nurseryman is fortunate who can afford to have a large packing and storage house which will afford sufficient space for holding all the stock that he anticipates disposing of during a shipping season. It is usually more convenient to dig and store nursery stock of all varieties in the fall. The ground is in better condition for digging than it is in the spring and there is usually more time in which to do the work. This done in the fall, there is more time in the spring for other work which is perhaps urgent. In such case, care must be exercised in storing away the nursery stock so as to prevent heating. Any house for this purpose should be judiciously ventilated. Much stock is injured by heating especially if packed in a cellar without proper ventilation.

FUMIGATION.

Under all circumstances a nurseryman should be provided with a convenient and well constructed fumigatorium, as every bundle of trees should be fumigated with hydrocyanic acid gas. Too much importance cannot be attached to this treatment of all stock of deciduous trees, even if there is no reason to believe that the stock is affected by any insect pest. Extensive experiments conducted by a number of reliable persons extending over many years has demonstrated conclusively that fumigation with hydrocyanic acid gas will not injure trees if properly conducted and further it is without doubt the most effective preventative of the distribution of any insect pest. The fumigation of the stock should be one person's business and he should be well trained in its operation. The size of the fumigatorium of course depends upon the amount of stock handled. Often it is very convenient to have two houses or rooms built in the packing house. In this connection, it may be added that all nurserymen should have a small fumigatorium in the form of a box, in which can be fumigated all buds, grafts, seedlings, etc.

The construction of the large fumigatorium will depend on circumstances. Some prefer a house large enough and so constructed that a wagon loaded with stock can be driven in it and left standing in order that the stock may be fumigated without an additional handling. This form has not proved entirely desirable in this state. Others take the form of a closed room either adjoining or built within the packing house. No matter what its shape may be, it should be carefully constructed in order to be practically air-tight.

In fumigating nursery stock, the trees should not be packed tightly in the room as this will prevent a free diffusion of the gas. Also a proper location in the fumigatorium should be selected to set the jar or jars in which the gas is generated.

Any one anticipating building a fumigatorium should consult this Station before doing so, as experience in such work affords opportunity for future improvements.

Finally, every precaution should be taken in the packing house to prevent the mixing of varieties, especially in getting up small shipments. All stock should be carefully scrutinized by expert eyes to detect any unsalable trees from passing by. Great care must be exercised in the packing of trees in carload lots, to prevent their roots from drying out or other injury. Shipments should not be sent out by nurserymen during a season when they are likely to arrive at their destination under adverse conditions of weather, that is, particularly, during freezing times. For such conditions cause the orchardists much trouble and anxiety.

It is, of course, to be considered that under the most favorable conditions and best regulated business operations, mistakes by thoughtless employees will occur. But nurserymen in particular should employ every means to prevent as far as possible any error which will not only reflect upon their reputation, but also at times entail severe pecuniary losses by their patrons.

LEGAL REQUIREMENTS.

This heading could more appropriately be called legal protection for the sentiments expressed in the law under which the inspection of nurseries and orchards is conducted are plainly set forth as a means of benefiting the horticultural interests. Further, it was the efforts of both nurserymen and orchardists of the state that brought about its passage.

The officers of the State Horticultural Department, whose offices were created by the horticultural law, desire to commend the nurserymen of Maryland for the hearty coöperation they have given in having the requirements of the inspection law carried out. There has been a marked improvement in the condition and healthfulness of the nurseries during the past few years and we have no hesitation in stating that in our opinion the condition of the nurseries of Maryland are in no way inferior to those of any state in the East.

The same may be stated in respect to the orchardists of the state. We believe that there is more spraying and other treatment given for the control of injurious insects and plant diseases in Maryland for its area than any other state in the Union.

There will, however, continue to exist careless and negligent persons, and it is our endeavor to enforce the law to the letter in the case of the nurseryman or orchardist where the exigencies of the case require it.

INSPECTION OF NURSERIES.

As required by law the nurseries of Maryland are inspected every six months. Of necessity and rightly, the inspection conducted in late summer and early fall is the most important, for at this time there is an ample opportunity for the inspectors to examine all stock subject to sale. This inspection is not commenced until after the 20th of August. A certificate issued on an inspection made before this date in this latitude would manifestly be of little value, since in the case of the San José scale for instance, there would yet be time for two or three broods of the insect and consequent dissemination before the cold weather or fall. The inspection should be conducted as late as possible in order to be completed in time for fall trade.

The inspection in this state is conducted as thoroughly as circumstances and funds will permit. It is obviously impossible for the inspectors to examine every salable tree in a nursery, especially in nurseries where over a million trees are to be gone over. It only remains for the inspectors to go through the blocks as thoroughly as possible, satisfying themselves as to the condition of the trees. We usually arrange to go through the blocks in the opposite direction from which they were planted at an average distance of 20 to 30 feet between inspectors. Thus in examining trees closely from the ground up in each row at this distance apart the inspectors will invariably detect the presence of any injurious pest. In fact, in our experience we have not as yet had a single case of infestation by an injurious pest develop later which we had not located during the inspection.

Upon detecting the presence of any injurious pest in a block of trees likely to be disseminated, we at once closely inspect surrounding stock and blocks. All trees found infested are immediately destroyed, and no trees are allowed to be sold from blocks in which infested trees were found until after a hand inspection of all the trees is made. As a further precaution, of course, all trees sold from nurseries in Maryland are required to be fumigated with hydrocyanic acid gas as it is inevitable that some small scale hidden beneath buds should escape notice. Thus we believe that the inspection of nurseries in Maryland is conducted on as high a plane as is possible, and that such inspection offers as much protection to orchardists and other growers as well as to the nurserymen themselves as is practical in the operation of such a law.

As has been stated, Maryland nurserymen readily comply with the requirements made by the officers charged with the enforcement of the law, and no certificate is issued to any nurseryman allowing him to sell nursery stock until after such requirements and agreements have been complied with.

ORCHARD INSPECTION.

The officers of the State Horticultural Department have continually sought more effective means of not only being of more assistance to nurserymen and orchardists in the protection and promotion of the horticultural interests of the state, but also the most amicable, practical, yet rigid means of enforcing the law.

It was apparent that the orchards of the state should be inspected, and it was difficult to devise means for a proper inspection with the limited funds at our command. In justice to the nurserymen of the state the orchards in the respective vicinity should be regularly inspected. For a time the officers of the department endeavored to visit as many parts of the state as possible, but this procedure, while being a great help, did not promote the work as was desired.

Later, various local inspectors who had been given a course at the Agricultural College, were appointed to take up the local inspection of orchards. This scheme of orchard inspection has been in operation for the past six years and continues to be the most effective plan to reach all parts of a given territory. While it is possible to inspect only a part of the state each season, the work will gradually cover the whole state. The local inspectors have their allotted territory each year in their respective counties. They are thus enabled to visit each individual orchard and report its condition to the office of the department. They come in personal contact with the grower and can point out injury caused by any pest or disease and advise him as to treatment.

Furthermore, by this local inspection a better acquaintance with the conditions in each locality is acquired and enables direct attention to be given to direfully neglected cases, and cause treatment either by showing the great necessity of same or, if necessary, enforce the law.

Furthermore, the local inspectors can explain the work of the department to the orchardists, and show them that our efforts are directed towards helping them in the protection of their trees and the production of good crops, rather than in seeing the law enforced. Twenty-seven local inspectors are working in Maryland this season. Thus the inspection of nurseries and orchards are conducted in Maryland with little or no friction, and the horticulturists as a whole are ever ready to support the work of the department.

MARYLAND HORTICULTURAL LAW.

For the benefit of those unfamiliar with the law governing such inspections in Maryland we herewith give that part of the law of 1898, Chapter 289, relating to same for their information and guidance.

"55. That in order to accomplish the purposes of this Act, the State Entomologist and the State Pathologist, their assistants and employes, or any other officer, assistant or employe appointed by said board of trustees, are hereby authorized to enter upon any public premises, parks, cemeteries, or other premises, or upon any land of any firm, corporation or private individual within the State of Maryland for the purpose of inspection, destroying, treating or experimenting upon the insects and diseases aforesaid. Should any insect or disease found by said State Entomologist or State Pathologist, or by any other officer appointed by said trustees, be, in their opinion, capable of eradication without the destruction of the tree or plant, then said officers are to treat or cause to be treated with proper remedies and appliances all such trees, vines, shrubs, plants and grains. Further, said state officers shall treat or have treated, in order to prevent the dissemination of the aforesaid insects or diseases, any and all suspicious trees, vines, shrubs, plants and grains found to be in a dangerous proximity to those infested as aforesaid.

"56. That should any of the officers aforesaid, through their assistants and employes, or by any notification whatsoever, find any fruit trees, vines, shrubs, plants or grains, infested or diseased with the aforesaid insects or diseases, the aforesaid officers shall mark or tag in some conspicuous way, all trees, vines, shrubs, plants or grains infested with the aforesaid diseases and shall give notice in writing to the owner or owners, tenants or person in charge of such premises of the condition thereof, and thereupon, if such person or persons so notified shall not within ten (10) days after notification, destroy or treat the same in accordance with regulations and rules of said trustees, a copy of which will be sent on application to any person, then said trustees shall, through their officers, assistants or employes, destroy or treat all such trees, plants, vines, shrubs and grains, and the state officers shall file a statement of the expenses of such destruction or treatment with the trustees of said college, and said trustees shall transmit a copy of such statement and account of such expenditure, with the usual affidavit attached thereto to be made by the state officers, which shall be sufficient evidence to prove the claim to the State's Attorney of the county where the owner of such premises resides, and said attorney is directed to collect the same and account to the Trustees of the Maryland Agricultural College therefor.

"57. That it shall be the duty of said trustees to send the State Entomologist, or the State Pathologist, or their duly authorized assistants, at least once a year into each county of the State for the purpose of determining by inspection the healthfulness and general condition of the horticultural and agricultural interests.

"58. That it is hereby also made the duty of the said board of trustees, through the State Entomologist and the State Pathologist, or their duly authorized assistants, to inspect at least once in every six (6) months, all nurseries of trees, vines, shrubs and plants, subject to the aforesaid insects or diseases within the state, and if found free, so far as can be determined by inspection, from the aforesaid insects or diseases, to give to the owner or owners or persons in charge of said nurseries, a certificate of inspection showing such nurseries or premises to be apparently free from such insects and diseases. If any of the aforesaid insects or diseases should be found in any nursery or orchard, or any premises within the State where nursery stock is grown, the aforesaid officers shall cause to be destroyed or treated such portion of such nursery stock or other trees or plants as in their opinion may be necessary, and shall release all other nursery stock grown upon said premises, and issue a certificate of inspection to the owner or owners as herein provided for; and if such infested or diseased trees, vines, plants or shrubs be destroyed by the aforesaid officers, then the owners shall pay the cost thereof, and if he refuse to pay the same it shall be collected as prescribed in section 56. No nurseryman, broker, agent, dealer or other person shall be permitted to sell, ship, send out, or give away, by mail, express, freight or otherwise, any trees, vines, shrubs, plants, buds or cuttings from any such nurseries or premises, without accompanying the same, with a copy of the said certificate printed upon a tag or label not easily destroyed, the same to be firmly attached in some conspicuous position upon each carload, box, bale or package so sent out or delivered.

"Sec. 2. *And be it enacted by the General Assembly of Maryland*, That the following sections be and the same are hereby added to Article XLVIII of the Code of Public General Laws, title "Inspections," subtitle "Horticultural Department," to be designated as sections 59, 59a, 60, 61, 62, 63, 64 and 65.

"59. That should any nurseryman, agent, broker, dealer or other person send out or deliver within the state, or transport to any other State or Territory, or the District of Columbia, trees, vines, shrubs, plants, buds or cuttings, subject to the attacks of insects and diseases above provided for, without attaching a copy of said certificate, deface or destroy said certificate, or wrongfully attach a certificate, he shall be adjudged guilty of a misdemeanor, and shall upon conviction before any justice of the peace be fined a sum not less than ten dollars ($10.00) or more than one hundred dollars ($100.00) and costs of prosecution for each and every offense, and stand committed until such fine and costs are paid, and the fines so collected shall be paid to the trustees of the said college, and be added to the funds herein provided for carrying out the provisions of this Act."

The following form of certificate is issued to nurserymen whose nursery stock is free from dangerously injurious insects and plant diseases.

CERTIFICATE OF NURSERY INSPECTION.

No. . . . . . .

To Whom It May Concern:

This is to certify, That on the . . . . day of . . . . . . 190 . . we examined the nursery stock of . . . . growing in . . . . nurseries at . . . . County of . . . . , State of Maryland, in accordance with the laws of Maryland, 1898, Chapter 289, Section 58, and that said nurseries and premises are apparently free, so far as can be determined by inspection, from the San José scale, Peach Yellows, Pear Blight and other dangerously injurious insect pests and plant diseases.

This certificate is invalid after . . . . 190 . . and does not include nursery stock not grown within this State, unless such stock is previously covered by certificate and accepted by the State Entomologist and State Pathologist.

. . . .
State Entomologist.

. . . .
State Pathologist.

College Park, Md. . . . . 190 . . .

In accordance with the law every shipment or bundle of trees, plants, shrubs, etc., distributed must bear a copy of the above certificate. Growers should be careful to examine the certificate to see that it is issued during the year that he received the consignment.

VARIOUS STATE LAWS.

In the passage of laws protecting and fostering their respective horticultural interests, as is to be expected, there is considerable variation in their requirements. The conditions of our state are different from those in other states. Also, the prevalence of different insect pests and diseases will vary in a marked degree in the different states of the Union.

With the great increase of the nursery business and the consequent expansion of area covered by the trade, the requirements of different state laws upon outside nurserymen has steadily grown in importance and in some instances make a hardship upon them. Much agitation has been brought about looking towards a national law covering the shipments of nursery stock for interstate commerce. The existence of so many state laws seems a barrier to enacting a national law to meet existing conditions. There is no doubt, however, that such legislation is looking towards diversity in requirements instead of uniformity, and no doubt sooner or later there will be sufficient sentiment abroad which will either demand a national uniform law or vigorous efforts will be made to bring about more uniformity in existing state laws.

For the information of our nurserymen who sell nursery stock in other states of the Union we give here a summary of the requirements of the laws on the statute books in the respective states.

The officers of the department will gladly aid any nurseryman in the state who holds our certificate in complying with the law of any other state by filing certificates from their office or other details in meeting such requirements.

A list of the names and addresses of nurserymen who receive certificates from the department will be furnished upon application.

The requirements of the several states and Canada, relative to inspection, certification and transportation of nursery stock, as accurately as we have been able to secure, are briefly summarized below together with names of the responsible officers in each:

Alabama: A signed copy of inspection certificate must be filed with the Secretary of the Alabama State Board of Horticulture, Auburn, Ala. Accompanying the certificate must be sufficient money to pay for the necessary Alabama tags. A tag must be attached to every package of nursery stock delivered in the state. Tags are furnished at the following cost prices: First one hundred (100), 65 cents postpaid; two hundred (200), $1.00 postpaid; five hundred (500), $1.60; one thousand (1,000), $2.00, sent collect by express. Nurserymen must attach one of their own certificates as well as an Alabama certificate to each bundle of nursery stock. Also the following insects and fungous diseases are quarantined against: San José scale, new peach scale, woolly aphis, crown gall, black knot, peach yellows, peach and plum rosette. Prof. R. S. Mackintosh, State Horticulturist, Auburn, Ala.

Arizona: No law except that which refers to the inspection of date palms grown within the state or shipped in from other states or territories. Prof. R. H. Forbes, Director, Agricultural Experiment Station, Tucson, Arizona.

Arkansas: All shipments of nursery stock into this state must be accompanied by a certificate of inspection issued by the proper state official and bear the name and address of consignee and consignor. Prof. C. F. Adams, Entomologist and State Inspector, Fayettsville, Ark.

California: Shipments of nursery stock into California are held by the transportation companies until inspected by county horticultural inspectors. All packages must be marked with the name and address of the shipper, name of the consignor, and name of the place where the stock is grown. All nursery stock infested with pests not existing in California will be immediately sent out of the state or destroyed at the option of the owner and at his expense. Peach, apricot, and almond trees coming from districts where yellows and rosette are known to exist, shall be refused entry and shall be destroyed or returned to the shipper. Notices of shipment of nursery stock to California should be sent to the county inspector at point of destination, or to Mr. Edward M. Ehrhorn, Deputy Commissioner of Horticulture, Ferry Building, San Francisco, Cal.

Colorado: New law in effect January 1st. Requires all shipments into the state to bear a certificate of inspection. Also that all nursery stock shall be inspected by county inspectors before being delivered to purchasers, unless the State Entomologist notifies the inspectors that the stock from certain nurseries can be admitted without inspection. All stock must be fumigated with hydrocyanic acid gas. Prof. C. P. Gillett, State Entomologist, Fort Collins, Col.

Connecticut: All shipments of stock into Connecticut must bear certificates of inspection issued by state or government officers, and statement (which may be made by the owner) that the contents have been thoroughly fumigated. Dr. W. E. Britton, State Entomologist, Agricultural Experiment Station, New Haven, Conn. (Amended act of 1903).

Delaware: Shipments of nursery stock into the state must bear certificate of inspection and also certificate stating that the stock had been properly fumigated. All nursery stock not accompanied by proper certificates may be held by the transportation companies until it can be inspected. Prof. Wesley Webb, Secretary State Board of Agriculture, Dover, Del.

Florida: Non-residents, persons or corporations, who sell nursery stock in Florida, must pay a license tax of $25.00 per annum to the Collector of Revenue of the county in which the nursery stock is to be sold and obtain from the county judge a license to do business. This is understood to mean that canvassers or peddlers for nursery stock if non-residents, must secure a license in each county of the state, but there is no interfering with the shipment of stock into Florida. There is no law governing the inspection of nursery stock, but Florida nurserymen secure certificates from Prof. W. E. Berger, Entomologist, Florida Agricultural Experiment Station, Gainesville, Fla.

Georgia: Nurseries are inspected annually. A signed duplicate of inspection certificate, together with a signed statement by the nurserymen that all stock intended for Georgia will be fumigated in accordance with directions furnished them, must be filed in the office of the State Entomologist. Official tags of the Georgia State Board of Entomology will be furnished by the State Entomologist at the following price: One hundred tags, 60 cents postpaid; 200 tags, 85 cents postpaid; 300 tags $1.10 postpaid; 500 tags, $1.35 sent by express collect; 1,000 tags, $2.00 sent by express collect. Each shipment of nursery stock into the State of Georgia must bear the official tag of the Georgia State Board of Entomology, and also a duplicate certificate of inspection of the state from which the shipment is made. (Regulations adopted Jan. 26, 1906.) Prof. E. L. Worsham, State Entomologist, Atlanta, Ga.

Hawaii: Shipments are subject to the regulations of the Board of Commissioners of Agriculture and Forestry and are subject to inspection and quarantine on arrival at Honolulu, which is the only port where they are allowed to be landed. For application blanks for inspection and special information, address Hon. C. S. Holloway, Secretary, Honolulu.

Idaho: No person can engage in the business of selling, or importing nursery stock without filing a bond of ($1000.00) one thousand dollars, with the Secretary of the State Board of Horticulture, and receive a permit, to do business within the state. Shipments into the state must bear a certificate of fumigation signed by a person duly authorized by the state where shipment originated, each package should also show the names of the consignor and consignee, also place where stock was grown. Shipment of peach stock from sections where peach yellows or peach rosette is known to exist is prohibited. Prof. J. R. Field, State Horticultural Inspector, Boise, Idaho.

Illinois: Nurserymen or agents desiring to sell stock into this state are required to furnish to the State Entomologist annually a sworn statement showing that the stock in which he deals has been duly inspected, and must submit for approval a copy of the certificate of inspection. All shipments into the state must be accompanied by a certificate of inspection. Dr. S. A. Forbes, State Entomologist, Urbana, Ill.

Indiana: Nursery stock shipped into the state shall be plainly labeled with the name of the consignor and name of the consignee, and a certificate signed by a state or government inspector showing that the contents have been examined. Prof. Benjamin W. Doughlas, State Entomologist, Indianapolis, Ind.

Iowa: Shipments of nursery stock into this state must be accompanied by a certificate of inspection, a copy of which should previously be filed for approval with the State Entomologist of Iowa. Prof. H. E. Summers, State Entomologist, Ames, Iowa.

Kansas: Nurseries are inspected annually between June 15th and November 1st. Certificates are valid until the first day of the following June. No nursery stock shall be brought into the state nor offered for sale within the state without having been previously properly inspected. (Laws of 1907). State Entomological Commission, Topeka, Kansas. Prof. T. J. Headlee, Entomologist, Manhattan, Kan., Prof. S. J. Hunter, Entomologist, Lawrence, Kan.

Kentucky: A copy of the inspection certificate and also a list of the contents should be attached to each bundle or package of nursery stock shipped into this state. To avoid possible delays, etc., a copy of the certificate should be filed with the State Entomologist. Prof. H. Garman, State Entomologist, Lexington, Ky.

Louisiana: Nursery stock delivered within the state must be labeled with an official certificate of inspection based upon inspection on or after July 1st and made within twelve months preceding time of shipment. Where several orders of nursery stock are shipped to an agent in one consignment each individual order must be tagged. Shipments not so labeled shall be liable to confiscation. The Entomologist has power to require any one in the state to fumigate trees and plants if deemed necessary. (Laws of 1903, State Crop Pest Regulations, 1907.) Prof. Wilmon Newell, Secretary, State Crop Pest Commission, Baton Rouge, La.

Maine: All shipments of nursery stock into the state must bear a certificate of inspection, or any box or package bearing a certificate of fumigation which shall be an affidavit made before a Justice of the Peace that all stock sold by the Consignor has been fumigated in a manner approved by the State Nursery Inspector of the state from which said nursery stock is shipped, the same may be accepted as though bearing a proper certificate of inspection. Prof. E. F. Hitchings, State Entomologist, Waterville, Maine.

Maryland: Nurseries inspected at least once in six months. All nursery stock subject to attack of insect pests must be fumigated under the direction of State officials. Shipments into the state must be labeled with the name of consignor and consignee and each package bear a certificate of inspection. Duplicate certificates should be filed. (Chapter 289, Laws of 1898.) Prof. T. B. Symons, State Entomologist; Prof. J. B. S. Norton, State Pathologist, College Park, Md.

Massachusetts: Nurseries are inspected once each year and certificates are issued by the State Nursery Inspector. No nursery stock shall be sold in the state unless the owners hold an unexpired certificate of inspection, unless however, all stock sold shall be fumigated with hydrocyanic acid gas in the prescribed manner, or who shall treat the stock which they sell by some other method approved by the State Nursery Inspector and who shall make affidavit before a Justice of the Peace that all stock sold by them has been fumigated or treated and who shall attach a copy of such affidavit to each package, box or car of stock sold, shall be exempt from the requirement of holding a certificate of inspection. All nursery stock shipped into the state shall bear a certificate of inspection or a copy of an affidavit of fumigation which meets the requirements of fumigation above specified. (Laws of 1907.) Dr. H. T. Fernald, State Nursery Inspector, Amherst, Mass.

Michigan: Nurseries are subject to inspection: infested trees must be destroyed and the remainder of the stock within a half mile must be fumigated. Shipments into the state must bear on every package, plainly labeled, the name of the consignor and consignee, statement of contents, and a certificate showing that the contents have been inspected by a state or government officer, and if of species subject to the attack of San José scale must be fumigated with hydrocyanic acid gas, and certificates of fumigation must also be attached together with a certificate of inspection. This applies to individual orders when several are contained in the same shipment. All nurserymen whether residents of Michigan or other states, who wish to grow or sell stock within the state must apply to the State Inspector of Nurseries on or before August 1st of each year for a license, for which the fee is $5.00, and a bond for $1000 must be filed. A license will not be granted until a state or government inspection certificate has been filed. (Laws of 1905.) Prof. L. R. Taft, State Inspector of Nurseries and Orchards, Agricultural College, Mich.

Minnesota: There is an annual inspection of all nurseries from which stock is shipped out of the state. Shipments into the state must be accompanied by a certificate of inspection. Carrying companies accepting packages of nursery stock without a certificate of inspection are liable. (Laws 1903). Prof. F. L. Washburn, State Entomologist, St. Anthony Park, Minn.

Mississippi: Every person or firm from other states wishing to ship nursery stock into Mississippi must file a copy of their certificate with the Entomologist of the Experiment Station. This certificate must state that stock has been fumigated under the directions of the official issuing the certificate. A copy of the certificate must also be attached to every bundle, bale, package, etc., of nursery stock delivered within this state. Prof. Glenn W. Herrick, Experiment Station, Agricultural College, Miss.

Missouri: Nurseries inspected annually. Every package of nursery stock shipped into the state shall be plainly labeled with the name and address of the consignor and the name and address of the consignee, and the contents, and a certificate showing that the contents have been inspected by a state inspector or a State Experiment Station Entomologist of the state from which the shipment is made, to show that the nursery stock is free from San José scale, peach yellows, peach rosette, or other dangerously injurious insects or diseases. Transportation companies are forbidden to deliver nursery stock unless accompanied by a certificate. Prof. J. M. Stedman, State Entomologist, Columbia, Mo.

Montana: All stock brought into the state must be unpacked, inspected and fumigated at one of the designated quarantine stations, viz: Miles City, Billings, Dillon, Missoula, Kalispell, Great Falls, Troy, Plains, Glasgow or Thompson Falls. Nursery stock may be inspected and fumigated at other points of delivery on payment of all cost. To sell or deliver nursery stock it is necessary to first obtain a license by paying a fee of $25.00 and by filing with the Secretary of the State Board of Horticulture a bond in the sum of $1000 annually. Notice of shipment including an invoice of stock, should be sent to the Secretary of the Board, Prof. Jos. W. Wallisch, Secretary State Board of Horticulture, Hibour Block, Butte, Mont.

Nebraska: No inspection law, but certificate of inspection should accompany shipments into the state. Nurseries are inspected by Prof. Lawrence Bruner, State Entomologist, University of Nebraska, Lincoln, Neb.

Nevada: No law governing shipments into this state. Prof. S. B. Doten, Entomologist Experiment Station, Reno, Nevada.

New Hampshire: All nursery stock shipped into this state must bear a certificate of inspection upon each bundle or package. A satisfactory certificate of fumigation will be accepted in lieu of an inspection certificate. Prof. E. D. Sanderson, State Entomologist, Durham, N. H.

New Jersey: Shipments of nursery stock into this state must be accompanied by a certificate, signed by an official inspector, certifying that the stock has been inspected and found free from San José scale and other dangerous injurious pests. If the stock has been fumigated it should be stated on the tag. No licenses and no fee or official tags are required in the state. Dr. J. B. Smith, State Entomologist, New Brunswick, New Jersey.

New Mexico: No law relating to nursery inspection.

New York: All shipments of nursery stock into this state must be accompanied by a certificate of inspection and bear name and address of the consignee and consignor. All shipments may be inspected and fumigated by state inspectors. Copies of the law and further information can be obtained of (the enforcing officer) Hon. R. A. Pearson, Commissioner of Agriculture, Albany, N. Y.

North Carolina: Nurserymen shipping stock into North Carolina must be in possession of valid certificate of inspection, and a copy of this certificate must be attached to each shipment or delivery. A copy of this certificate must also be previously filed in the office of the Entomologist. It is not required that nurserymen shall secure tags from us to attach to their shipments and it is not required by law that stock coming into the state shall be fumigated, but it is greatly to the advantage of the nurserymen if he can give assurance that his stock has been thus treated. Prof. Franklin Sherman, Jr., Entomologist, Department of Agriculture, Raleigh, N. C.

North Dakota: No law. Prof. C. B. Waldron, Entomologist, Agricultural College, North Dakota.

Ohio: Nurseries are inspected each year, and certificates are issued which are valid for one year. Provision is made for the official certification and fumigation of nursery stock. Nursery stock shipped into the state must be labeled on the outside with the names of the consignor and consignee and be accompanied by an official certification of inspection or fumigation. Agents and dealers who sell stock within the state must file a sworn statement as to the source from which said stock was obtained and that it has been officially inspected. Mr. N. E. Shaw, Chief Inspector, Department of Agriculture, Columbus, Ohio.

Oklahoma: The owners or operators of nurseries who desire to ship stock into the state of Oklahoma are required to make an application for a permit. This permit is issued by the Board of Agriculture upon the filing of a duplicate certificate of inspection, or report of inspection from the State Inspector, who examined the stock, and in addition the application must be accompanied by a remittance of $5.00. If satisfactory the Board issues a permit over the signature of its secretary, and in addition to the above may require further evidence of integrity to establish the responsibility and good faith of the applicant. All shipments must be accompanied by a tag, on which is printed a copy of this permit over the fac-simile signature of the Secretary of the Board. All agents canvassing for nurseries located outside the state are required to carry a duplicate of the permit of their principal, which duplicate is issued upon payment of $1.00. Quotations on tags will be given upon application to the secretary. (Act of 1905.) Address all communications to the Oklahoma State Board of Agriculture, C. F. Barrett, Secretary, Guthrie, Okla.

Oregon: All shipments of nursery stock into this state must be inspected at quarantine stations or at point of destination before delivery to the consignee. The importation of peach trees from districts known to be infected with little peach or with peach yellows is prohibited. Mr. H. M. Williams, Secretary State Board of Horticulture, Portland, Oregon.

Pennsylvania: Shipments of nursery stock into this state must be plainly marked with the names of the consignor and consignee, and must be accompanied by certificates showing that the contents have been inspected and that the stock (excepting conifers and herbaceous plants) has been properly fumigated. Agents and dealers in nursery stock are furnished with certificates under certain restrictions. Transportation companies are required to reject all consignments entering this state unless certificates of inspection and fumigation are attached. Prof. H. A. Surface, Economic Zoölogist, Mr. E. B. Engle, Nursery Inspector, Harrisburg, Pa.

Porto Rico: Nursery stock will be received only through three ports of entry, namely, San Juan, Ponce, and Mayaguez, and must be accompanied with an official certificate of inspection. It is subject to inspection by local inspectors on arrival at said ports of entry. Inspectors are appointed by the Governor. (Act of 1905.)

Rhode Island: Nursery stock shipped into the state must bear an inspection certificate or a fumigation affidavit, and all stock not so labeled must be returned to the consignor. (Chapter 159 Laws of 1904.) Mr. A. E. Stene, State Nursery Inspector, Kingston, R. I.

South Carolina: Nurserymen residing without the state of South Carolina, but who are doing business therein, are required to file in the office of the South Carolina State Board of Entomology, Clemson College, S. C., their certificate of inspection and fumigation furnished to them by the entomologist of the state in which the stock is grown. To those who comply with the above requirements, the official tags of the Board are issued, upon order, at a cost of eighty-five cents for the first one hundred and fifteen cents for each additional one hundred. Prof. Chas. E. Chambliss, State Entomologist, Clemson College, S. C.

South Dakota: Out-state nurserymen desiring to do business in this state must first make application for a permit from the Secretary of the State Board of Agriculture accompanied with a fee of $10.00 and filing a copy of their official certificate in said office. Mr. C. N. McIlvaine, Secretary State Board of Agriculture, Huron, South Dakota. Prof. Robert Matheson, State Entomologist, Brookings, S. D.

Tennessee: Nurseries are inspected annually. Certificates are issued not later than November 1, and become void after August 1 of the following year. Parties shipping nursery stock into Tennessee must file duplicate certificate of inspection, signed in person by proper official, with the Secretary of the State Board of Entomology, Knoxville, Tenn. A certficate of inspection must be attached to each package of nursery stock shipped into the state. All nursery stock shipped or delivered within the state must be fumigated before delivery. Prof. H. A. Morgan, Secretary State Board of Entomology, Knoxville, Tenn.

Texas: Nurserymen desiring to sell stock in this state must first file a certified copy of the certificate of inspection issued by the state or government inspector showing that the stock has been examined and found apparently free from all dangerously insect pests and diseases, and where fumigation is required it must show that the stock has been fumigated. On filing such certificate a fee of one dollar ($1.00) is charged. All shipments must be accompanied by a copy of said certificate attached. Hon. R. T. Wilmer, Commissioner of Agriculture, Austin, Texas.

Utah: Any person, firm or corporation, selling stock within the state must first obtain a license from the State Board of Horticulture. Five dollars for any annual business below $1,000; $10.00 for any annual business over $3,000, and under $10,000; $50.00 for any annual business over $10,000, and by filing with the Secretary of the Board a bond in the sum of $500.00 conditioned that the principal will comply with the law and pay the cost of fumigating nursery stock imported or sold within the state, and the expense of destruction of any infected stock. Licenses are granted for one year. Shipments of nursery stock (except conifers and delicate ornamental plants) into the state must be accompanied by a certificate of fumigation or disinfection by hydrocyanic acid gas before shipment. (Law of 1907.) It shall be the duty of persons, firms or corporations to provide their salesmen or agents with a certificate of the State Board of Horticulture, stating the name of such agent and name and address of the firm they represent, together with the license number of such firm; to attach a copy of the certificate of inspection to each delivery of trees into the state; to file with the Secretary of the State Board of Horticulture, a statement of their annual business when making application for license, and when printed copies of certificates of fumigation are used, they shall file with the Secretary of the State Board of Horticulture a duplicate (not a copy) of the original certificate. (Rules, February 27, 1908). Mr. J. Edward Taylor, Secretary State Board of Horticulture, Chamber of Commerce, Salt Lake City, Utah.

Vermont: No law. Mr. Wm. Stuart, Horticulturist, Agricultural Experiment Station, Burlington, Vt.

Virginia: Nurserymen must file a copy of their certificate of nursery inspection with the State Entomologist, Blacksburg, Va. Application must also be made to the Auditor of Public Accounts, Richmond, Virginia, accompanied by certified check or draft for $20.00 drawn or endorsed payable to the Treasurer of the State of Virginia. Personal checks will not be accepted. A copy of the certificate of registration issued by the Auditor should be in the hands of each agent. These duplicates may be obtained free by applying to the State Entomologist. When stock is shipped into this state, each carload, box, bale or package must be accompanied by the official tag of the State Entomologist, which can be obtained at cost of printing by applying to his office. Prof. J. L. Phillips, State Entomologist, Blacksburg, Va.

Washington: No person, firm or corporation shall engage or continue in the business of selling as agent, solicitor, or otherwise, within the state, or importing nursery stock without first having obtained a license. Application therefor must be made to the Commissioner of Horticulture, together with a satisfactory bond of $1,000; each bond must be renewed each second year. Such bond shall be conditioned that the principal or his agents, will obey the provisions of the law, and that said principal will pay the cost of disinfection or destruction of all infested nursery stock and fruit sent into the state by said principal or his agents. The license fee for nurserymen and tree dealers shall be $5.00, and for other agents or salesmen $2.50. All licenses expire two years from date of issue unless renewed upon the same terms originally provided for. Every person licensed to do business in the state must notify the Commissioner of Horticulture of his intention of shipping nursery stock, giving the names and addresses of the persons, firms or corporations to whom they are sold. Such notice shall contain the name and address of both consignor and consignee, an invoice of the goods to be shipped and point from which they are to be delivered. A copy of such notice shall also be sent to the county horticultural inspector of the county in which the point of destination is located. For full information address Mr. F. A. Huntley, Commissioner of Horticulture, Tacoma, Washington.

West Virginia: Nurseries are inspected and certified once each year. Certificates are valid for one year from the 15th of September. No persons shall deliver any nursery stock consigned to points in the state from points without the state unless at least ten days before the time of delivery a notice in writing is given to the Director of the West Virginia Experiment Station, Morgantown, W. Va., of the number of trees in such consignment, and the place from whence such trees were shipped and the destination of the same, and said director may cause the inspection, fumigation or destruction of the said stock if found infested with San José scale or any infectious disease. (Laws of 1907.) Every person who employs traveling salesmen for the sale of nursery stock shall take out a license in some county of the state for which he shall pay a fee of $10.00 per annum. Every such principal shall file with the clerk of the county a list of all agents or salesmen. (Laws of 1905.) Mr. J. B. Garvin, Secretary, Board of Agriculture, Charleston, W. Va.; Prof. J. H. Stewart, Director Agricultural Experiment Station, Morgantown, W. Va.

Wisconsin: All shipments of nursery stock into this state must be accompanied by a certificate of inspection issued by the proper state or government official and bear the name and address of consignee and consignor. Prof. E. P. Sandsten, Inspector, Madison, Wis.

Wyoming: Any person or firm wishing to do business in this state must first obtain a license. Licenses are issued on application for a period terminating on July 1 of the next succeeding inspection year (approximately two years). All applications must be accompanied by the license fee ($25.00), a bond in the sum of five hundred dollars ($500) conditioned that the principal will faithfully obey the law of the State of Wyoming, and by a certified certificate of inspection from an authorized inspector in the state from which shipments are to be made. On receipt of these, the Secretary of the State Board issues authorized shipping tags (at cost). Nursery stock may not enter the state, and transportation companies may not deliver unless such tag be attached to each and every box, bundle or bale. The presence of the shipping tag shall be taken as prima facie evidence of inspection and no further inspection is required, though the Board reserves the right to reinspect if for any cause it may deem it wise to do so. Notice before shipment should be made to, and a circular of information obtained from Prof. Aven Nelson, Secretary State Board of Horticulture, Laramie, Wyo.

Canada: All nursery stock coming into this country from countries where the San José scale has been found, must be fumigated at one of the designated ports of entry by a federal official, at government expense. All nursery stock must be imported through one of the following ports of entry between the dates specified: Winnipeg, Man., and St. John, B. B., between March 15th and May 15th, or between October 27th and December 7th; Windsor, Ont., Niagara Falls, Ont., and St. Johns, Que., between March 15th and May 15th, or between September 26th and December 7th. At Vancouver, B. C., during the winter months only, between October 1st and May 1st. Dr. James Fletcher, Dominion Entomologist, Ottawa, Canada.

British Columbia: For this province all shipments of nursery stock will be inspected at the Inspection Station, Vancouver, B. C. Nurserymen are required to put up bonds in the sum of two thousand dollars ($2,000), and to take out licenses before being allowed to sell nursery stock in the provinces. Mr. J. R. Anderson, Deputy Minister of Agriculture, Victoria, B. C.

Ontario: All shipments of nursery stock from the United States into Ontario must come by way of Dominion fumigating houses at Niagara Falls or Windsor (see note above as to Canada). Sale of infested nursery stock is prohibited. All domestic nursery stock must be fumigated under supervision of officers of Provincial Department of Agriculture, Mr. C. C. James, Deputy Minister of Agriculture, Toronto, Ont.

NATIONAL LAWS.

As mentioned heretofore there is no national law governing inspection or transportation of interstate shipments of nursery stock.

There is also no law governing the inspection of imports or exports. It is hoped that such a law will shortly be enacted to prevent as far as possible the introduction of any new pests from other countries in such shipments.

INSTRUCTIONS TO OUT-STATE NURSERYMEN.

Section 60 of the Maryland law plainly defines the requirements of nurserymen outside of the state desiring to sell nursery stock in the state and is here inserted for their information.

"That when any trees, plants, shrubs, vines, buds or cuttings, commonly known as nursery stock are shipped into the state from any other state or territory, or the District of Columbia, to any nurseryman, broker, dealer, agent or other person in this state, every carload, bale, box or package thereof shall be plainly labeled on the outside with the name of the consignor, the name of the consignee, and a certificate showing that the contents have been inspected by a qualified state or government officer, and that the trees, plants, vines, shrubs or cuttings therein contained are apparently free from the insects and diseases herein provided for. Whenever any trees, plants, vines, shrubs, buds or cuttings are shipped into this state from any other state or territory, or the District of Columbia, without such certificate plainly fixed on the outside of each carload, box, bale or package, the agent of the transportation company, firm or person, receiving same shall not deliver said nursery stock to the consignee or agent representing the consignor, and said agent of the transportation company, firm or person, shall notify the State Entomologist or State Pathologist at the Maryland Agricultural College, and said state officer receiving such notification shall immediately notify any justice of the peace of this state to issue a summons for the consignee, and the agent or consignor, if he be known, of such carload, bale, box or package of nursery stock, to appear before him on a certain day to be named therein, to show why such trees, plants, vines, shrubs, buds or cuttings should not be seized as being in violation of the provisions of this Act, and on trial thereof, if said justice be satisfied that the provisions of this Act have been violated, said justice shall order said agent or consignee to return such carload, box, bale or package of trees, plants, shrubs, vines, buds or cuttings, immediately to the shipper or consignor, unless said consignee or agent of the consignor at his expense, shall forthwith have said nursery stock examined by the State Entomologist and State Pathologist of this state, and such officers certify to such justice of the peace that said nursery stock is apparently free from the insects and diseases mentioned herein, and tag every such carload, box, bale and package inspected by said officers, with their certificate of inspection, and if said agent or consignee shall fail to have said nursery stock examined by said state officials, or fail to return such carload, box, bale or package thereof, then said justice of the peace shall order and direct the constable or sheriff to burn and destroy all such trees, plants, shrubs, vines, buds or cuttings that have been shipped into this state in violation of this Act."

"61. That whenever any agent of a transportation company, firm or person, shall receive a carload, box, bale or package of trees, plants, shrubs, vines, buds or cuttings without a certificate attached, as provided for in Section 60 of this Act, and shall fail to notify the state Entomologist or State Pathologist of this fact immediately upon the arrival of such nursery stock, and before delivering the same to the consignee, said agent of the transportation company, firm or person shall be adjudged guilty of a misdemeanor, and shall upon conviction before a justice of the peace, be fined a sum not less than ten dollars ($10.00) nor more than one hundred dollars ($100.00) and costs of prosecution for each and every offense, and stand committed until such fine and costs are paid; and the fines so collected shall be paid to the trustees of said College to be added to the funds herein provided for carrying out the provisions of this Act. If any nurseryman, dealer or agent, sell, ship or deliver any trees, plants, shrubs or vines into or in this state, which is infested with San José scale, peach yellows, pear blight or other injurious diseases, and upon examination by the State Pathologist, State Entomologist or their assistants, is condemned by being so infested, the said trees, plants,vines and shrubs shall be destroyed, and the nurseryman, dealer or agent shall forfeit the value of such stock, and shall not collect the same from the purchaser or consignee."

All nurserymen who desire to do a business in this state should file with the State Horticultural Department, before making such shipments a copy of their nursery inspection certificate. We desire these certificates to determine, as far as possible, by whom the inspections were made. No tags from this department are necessary on shipments into the state. Simply attach copy of your certificate of nursery inspection, and shipments will be delivered by our transportation agents. It is not desired to in any way restrict the commerce of outside nurserymen in this state, but any violation of the above section will be immediately dealt with.

COÖPERATION OF RAILROAD AGENTS.

As will be seen in section No. 61 of the Maryland Law, that agents of all railroads or transportation companies are compelled to hold up any shipment of nursery stock either from within or without the state, that have not attached an up-to-date copy of an official certificate of nursery inspection, issued by a regular state official.

Failure on their part to report to this department any irregularity in the shipments of nursery stock will be considered a misdemeanor and shall upon conviction thereof be fined a sum not less than ten dollars ($10.00) and not more than one hundred ($100.00) and costs of prosecution for each and every offense.

We must have the aid and coöperation of all agents in the state in order to rightly perform our duties and prevent the dissemination of uninspected and uncertified stock.

RELATION OF FRUIT GROWERS TO NURSERYMEN.

The relation between fruit growers and nurserymen should be most cordial and candid for each must depend on the other. The nurseryman could not exist without his fruit grower customers, and on the other hand few trees would be planted if each man had to propagate his own. To be successful, the nurseryman must have the confidence of the fruit grower. There have been times when the fruit grower was justified in condemning the nurseryman in strong terms because the trees were not of the grade or variety purchased and paid for. There is nothing meaner in the whole business of fruit growing than for a nurseryman to sell and agree to deliver one variety, and then without the knowledge or consent of the customer to deliver some other variety, no matter if it is done by intention or by error. If the fruit grower wants to order Ben Davis apple trees it is the nurseryman's duty to deliver Ben Davis and nothing else. If he cannot furnish Ben Davis trees it is his duty to say so and then to obtain permission before substituting some other variety. It is a satisfaction to know that reliable nurserymen are honorable in this matter and may be depended on to deal fairly.

When a fruit grower decides upon planting trees he should make out a list stating what he wants; that is, the names of varieties, the number of trees of each variety, the age and size, low headed or high headed, root grafted or budded, and submit this list to the nurseryman asking first if he can furnish the trees as specified, and second at what price. Dealing direct with the nurseryman is best, then he can be held responsible if the trees are not as represented. Nurserymen who win the confidence of, and deal fairly with, their customers, need not worry about future sales. One honest deal will be followed by many orders.

As a rule it is best to deal with the nearest reliable nurseryman, then shipments will be shorter and freight or express bills less than when dealing with distant firms.

Personal acquaintance between nurserymen and fruit growers is most desirable.

Growers are warned against the practice of entering into a contract with a tree agent or nurseryman in paying a high price for the trees with the understanding that the agent or nurserymen will care for the trees for a number of years or until some commence bearing. In certain cases the agent has left the locality or the nurseryman closed out the business of the firm issuing these contracts, continuing the business under a new name. Such unreliable firms, and it may be added there are but few in the country, extort from the grower a high price for the trees with no intention of fulfilling their contract in caring for the trees, and if they do they are usually not in a position to give the orchard the attention that it deserves and requires.

Maryland growers may have confidence in the Maryland nurseryman as a whole, for we believe that the men engaged in the nursery business in this state have the interests of the purchaser at heart and will spare no means to give entire satisfaction.

Some of our nurserymen have large variety orchards fruiting which enables them to learn the characteristics of any comparatively new varieties and check upon the old. It also affords opportunity to secure vigorous buds for the nursery which is vital in the production of good trees.

Further, in but few instances have we experienced any irregularity by outside nurserymen. Most states have laws similar to ours and require all stock to be inspected and fumigated, and this Department requires the nurseryman wishing to do business in this state to first file a copy of his official certificate in this office. By this means we know who inspected the nurseries and also the firms that intend to do business in the state.

GROWERS AND THE LAW.

The Maryland horticultural law was passed at the instance of both growers and nurserymen of Maryland and its enforcement presents duties and obligations to both, as well as extends privileges and protection alike. The grower must protect the trees in the orchard from serving as a public menace in the distribution of any pest, the nurserymen must protect the trees in the nursery in order that their distribution will not disseminate injurious insects or diseases.

It is due the orchardist that in a contract with the nurserymen for so many trees at such a price, that he receive his money's worth of good sound, clean trees or plants; and ignorance on the part of the nurseryman in sending out diseased trees or plants is not excusable for breaking his contract with the orchardist. It is likewise due the nurseryman that he secure a reasonable profit from his business, and if the expenses in connection with keeping his nursery free from the various pests accordingly increases the cost of production, the price of good nursery stock must certainly increase at a corresponding rate. We believe in a thorough inspection of the nurseries and we believe that the nursery men as a whole are desirous of such an inspection being as rigid as possible. But it is due them that such inspection, together with the requirements following it, entail as little loss and trouble as is consistent in the distribution of good, clean, healthy nursery stock.

In order to obtain the best results in our efforts to guard the interests of all concerned we must have the coöperation of all parties.

It is the duty of the grower to notify the officers of the department whenever they observe that the sections of the law relating to the certification and transportation of nursery stock have been violated either by nurserymen within or without the state. Upon receiving such information the officers will immediately investigate and correct the irregularity. There is hestitancy on the part of some growers even to-day against planting trees that have been fumigated with hydrocyanic acid gas. There is no reason for this doubt, for it has been conclusively demonstrated not only by this Station, but by many others in the country that nursery trees will stand fumigating without injury with this gas double and three times the recommended strength used by nurserymen in this state; when conducted in the proper manner. If any one desires to see further evidence we will be pleased to send him bulletin No. 105 of this Station in which the subject is thoroughly discussed.

Further, fumigation is the best assurance that the nurserymen can give the orchardists as a preventive in the dissemination of injurious insects. The grower therefore must insist that the nurserymen should, as required by law, fumigate his trees in a proper manner and report to this department failure on the part of nurserymen to comply with same.

SIZE AND GRADE OF NURSERY TREES.

Usually the grade of a nursery tree is determined by its height, straightness of trunk, and caliper at a point three inches from the ground. This rule of size, straightness and trunk caliper, holds for those varieties which are good growers in the nursery, but there are others, and desirable ones too, like Rhode Island Greening, which are crooked growers and make first-class trees even though they are crooked. A first-class tree should be well grown, be healthy and vigorous, have the peculiar characters of the variety (this allows crooked trunks if they result from the natural habit of the tree), be free from insect and disease blemishes, with smooth clean bark and stocky trunk, have the union of cion or bud with stock healed over, and be mature (this means that the green leaves should not be stripped off before they are ready to drop naturally).

Low-headed trees can not of course be graded in height with high headed ones of the same grade, nor can one year old trees compare in all respects with two year olds of the same grade. A general standard for grading is adopted by most nurserymen and this in a measure answers the purpose if the stock is about the same age and character when sold. Now that low headed and one year old trees (besides the peach) are demanded, it might be a good plan to adopt certain measurements for low-headed trees and others for high-headed trees one year old, and other measurements for high-headed trees and low-headed trees two years old, etc.

However, the main point is this—see to it that the nurserymen ship the grade they accept pay for. When writing for prices of trees of different grades, ask them to give measurements of each grade and then refuse to accept any trees not up to those measurements. In other words let the nurseryman establish his grades and make him live up to them.

One nursery firm in Maryland grades its stock as follows:

APPLE, CHERRY AND PEAR.

1st grade— $\frac{3}{4}$ inch caliper and up—5 to 7 feet high.
2d “ $\frac{5}{8}$ to $\frac{3}{4}$ “ “ “ 5 to 6 “ “
3d “ $\frac{1}{2}$ to $\frac{5}{8}$ “ “ “ 4 to 5 “ “
4th “ —3 to 4 feet high.
5th “ —2 to 3 “ “

PEACH.

1st grade— $\frac{9}{16}$ inch caliper and up—4 to 6 feet high.
2d “ $\frac{1}{2}$ to $\frac{9}{16}$ “ “ “ $3\frac{1}{2}$ to $4\frac{1}{2}$ “ “
3d “ —3 to 4 feet high.
4th “ —2 to 3 “ “

It will be noticed that nothing is said regarding age of the apple, cherry and pear stock above, and the measurements all refer to high headed trees. The peach stock is one year old.

CARE OF TREES UPON ARRIVAL.

As soon as shipments arrive the boxes or bales should be opened at once and the trees be heeled in immediately unless they are considerably dried out, in which case they should be buried in damp ground for several days and then be heeled in. To heel in trees in fall for remaining over winter, dig a trench 15 or 18 inches deep running east and west with south side sloping and place the roots in the trench with the tops slanting to the south. Dig away the north bank of the trench and throw the earth over the roots and half way up the trunks and tramp down well. Place another row of trees in the new trench and proceed as before. The roots and part of the trunks must be well covered so they cannot dry out. The object of pointing the tops to the south is to have the branches shade the trunks and thus prevent any injurious action by the winter sun on the trunks as might occur if the tops are pointed in any other direction.

For spring heeling in it does not matter how the tops are placed so long as the roots are kept moist.

It is often the case that when the proper way of heeling in trees is not understood, the roots are only partly covered and they dry out to the extent that the trees make only a weak start, if any, and die during the first season. Naturally, the nurseryman is blamed for sending poor trees although they are first-class and the fault lies entirely with the purchaser.

PLANTING THE TREES.

In digging nursery trees the root system is injured and about seven-eighths or more of it is left in the ground. Since the root system is reduced so much the top must be reduced proportionally to maintain a fair balance between top and root. The roots should be pruned so as to leave only three or four inches of each one. All bruised parts should be pruned off and all cuts should be clean and smooth. The tree is then in shape to be quickly and easily planted for a slight up and down movement of the tree while the earth is being thrown in, will settle the earth around the roots where it should be firmly packed. If the ground is well prepared the holes for the trees need not be very large, but if it is hard or in sod it is well to make them three or even four feet across.

The tops should be pruned leaving spurs with two to four buds each, and the "leader" should be cut off about two and one-half feet from the ground. The more foliage the better on the little trees because leaves increase the circulation and assimilation of the sap and shade the trunks.

CONCLUSION.

In conclusion the writers have endeavored to discuss plainly the various aspects of tree growing from the bud to the orchard field. The suggestions offered embody the results of our experience and observation in the work from conditions as presented in Maryland. There are given parts of the Maryland law which affect both nurseryman and grower and also a summary of the laws of other states giving information as to their respective requirements.

The discussion of the inspection of nurseries and orchards is given for the benefit of all concerned with the hope that there will continue the confidence which should exist among all parties interested.

The officers of the Department solicit the coöperation of all concerned for by this means only can the greatest good result in the promotion of horticulture in Maryland.

There are abundant opportunities for successful orcharding in the state and we should all make every effort to promote the industry and and cause Maryland to be more prominently known as a horticultural state.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 131 NOVEMBER, 1908

MISCELLANEOUS TREATMENT FOR SAN JOSÉ SCALE

BY THOMAS B. SYMONS

INTRODUCTION

The control of the San José scale in Maryland has reached the point where spraying for the pest each year is considered by the progressive orchardist as routine work. The home-made lime-sulfur wash is thoroughly established as an effective and cheap remedy for the pest. In addition it has fungicidal properties which usually control the peach leaf curl. The trouble and time involved in making this wash has led orchardists to desire reliable information with regard to the effectiveness in combating the scale, the fungicidal properties, and the general effect on the trees of the various other washes on the market. To this end experiments have been conducted by the Department to test the value of some of these manufactured washes. The results and our recommendations are given under the head of spraying experiments.

The necessity for all nurserymen to fumigate their propagating stock with hydrocyanic acid gas suggested the need of further investigation to ascertain what strength of the gas and duration of exposure would be most certain to kill the scale without injuring the stock. Hence fumigation Experiments I and II. Experiment III gives additional data on the effect of the gas on salable trees.

During the past two or three years nurserymen and orchardists have been discussing the dipping of nursery trees in an insecticide as a substitute for fumigation with hydrocyanic acid gas. This discussion suggested the conducting of experiments to ascertain whether such treatment would be advisable as regards its effect on the tree, and efficiency in preventing the distribution of the San José scale. The discussion following Experiments I, II, and III under dipping Experiments gives the results and our recommendations for this method of treatment.

These experiments on the whole are not as extended as was desired, but the results obtained will indicate what may be expected in actual practice.

The success attending the operation of public sprayers by this department during the past year justifies a reference to this part of the department's work with the hope that it may induce private interests to further engage in this business.

The Department expresses thanks to Messrs. R. P. Beckley of Halfway, Maryland, and Ed. G. Emack of Beltsville, Maryland, for the use of their orchards in conducting the spraying experiments.

Credit is cheerfully given to Mr. A. B. Gahan for able assistance in attending to the details of the dipping experiments in 1906; to Mr. Geo. P. Weldon for his careful work in conducting the experiments in the fumigation of trees and buds and dipping tests in 1906 and 1907, and to Mr. L. M. Peairs for superintending the spraying and dipping experiments conducted during the past season.

SPRAYING EXPERIMENTS.

A number of new patent washes have been put on the market during the past year for the control of the San José scale. In order to answer inquiries regarding them intelligently it was necessary to test them in actual practice. There is no doubt that the activity of these manufacturers in placing the different mixtures on the market has in the majority of cases had a good effect in promoting general spraying operations. Growers should be careful, however, about using any of the new mixtures before they have been thoroughly tested.

While possessing a spirit of coöperation with all in the endeavor to secure the best insecticide for any given pest we deem it our duty to the public to give actual results obtained in our tests and to speak frankly in giving our recommendations deduced from these experiments as well as from general observations throughout the state.

All the spray solutions were applied in the apple orchard of Mr. R. P. Beckley of Halfway. The orchard consisted of about 400 ten year old trees rather small for their age, all more or less badly infested with scale. The trees were sprayed March 27 and April 3, 1908. A strong wind on the first day interfered with the spraying to some extent, although on the whole the sprays were applied in a very satisfactory manner.

A further experiment with the concentrated lime-sulfur wash was conducted in the peach orchard of Mr. E. G. Emack at Beltsville, Maryland. The orchard contained about 100 trees, four years old.

No attempt was made to conduct these tests upon a commercial basis, for in this case, as with all insecticides, the point first to be determined is the degree of efficiency of any wash when applied as thoroughly as possible. If a wash is shown to be efficient when thoroughly applied, the success or failure attending its use on a commercial scale will depend upon the ease of application and the quality of the work done.

EXPERIMENT I.

HOME-MADE LIME-SULFUR (20 – 15-50).

The standard lime-sulfur wash was applied on twenty-nine trees in the orchard. This was applied primarily for comparison with the other washes. On account of the wind, it was more difficult to spray thoroughly at the time of applying this wash than any other in the experiment. The results were therefore not quite so good as have been secured in former tests. The treatment, however, can be considered satisfactory, as only a small amount of scale could be found at the final examination of the trees in this test.

EXPERIMENT II.

NIAGARA BRAND CONCENTRATED LIME-SULFUR (APPLIED 1 to 12 and 1 to 9).

This is a new wash placed on the market by the Niagara Spray Company, Rochester, New York. As its name indicates it is a concentrated lime-sulfur solution. Twenty-six trees were sprayed with the solution. It mixed readily with water and at the strength of 1 to 9 gave very good results. Some differences in favor of the stronger solution was noted.

EXPERIMENT III.

ORCHARD BRAND LIME-SULFUR (APPLIED 1 TO 12 AND 1 TO 9).

This is also a new spray placed on the market by the Thomsen Chemical Company of Baltimore, Maryland. Thirty-three apple and about one hundred peach trees were treated with the preparation.

Like the above it readily mixed with water and proved very effective, the stronger solution giving better results.

EXPERIMENT IV.

REX LIME-SULFUR (APPLIED 1 TO 12 AND 1 TO 9)

This concentrated wash has been on the western markets for two years. It is sold by the Rex Company of Omaha, Nebraska. The solution was employed in our tests of 1907 and gave then, as on this occasion, very good results. A favorable difference was noted in the use of the stronger solution. Of all the concentrated lime-sulfur washes this seemed to remain on the trees the longest period and this no doubt accounts for its apparent slightly greater effectiveness.

EXPERIMENT V.

SAN-U-ZAY (APPLIED 1 TO 15 AND 1 TO 20).

This oil solution was brought to our attention by the T. S. Southwick Company of Rochester, New York, who desired that it be tested on San José scale at the strengths of 1 to 10, 1 to 15 and 1 to 20. On account of lack of material we were able to apply it only at the two latter strengths. The solution is now being sold by the F. G. Street Company of Rochester, New York. The oil being of a heavy grade, some difficulty was experienced in getting the solution to mix with water as readily as other miscible oils. Also it showed a tendency to coagulate in the spray barrel when mixed with very cold water. No reason can be given for this action as the company claims it to blend instantaneously with any kind of water. Twenty-two trees were sprayed with the two strengths of the mixture. While there is a little difference in the final results of the two strengths, the treatment proved ineffective, and from these tests cannot be considered a satisfactory remedy for the pest at the strengths indicated.

EXPERIMENT VI.

TARGET BRAND SCALE EMULSION (APPLIED 1 TO 15 AND 1 TO 20).

This solution, which has been on the market for some time, was again included in our tests. It is sold by the Horticultural Distributing Company of Martinsburg, West Virginia. Thirty-three trees were sprayed with two strengths of the solution which is easy to apply and readily mixes with water.

The results from the 1 to 15 solution were satisfactory, the trees sprayed showing only a small amount of scale at final examination.

EXPERIMENT VII.

ORCHARD BRAND SOLUBLE OIL (APPLIED 1 TO 15 AND 1 TO 20).

This soluble oil is sold by the Thomsen Chemical Company of Baltimore, Maryland. The solution readily mixes with water and is easy to apply. Thirty-five trees were sprayed with the two strengths of solution.

The results from the 1 to 15 solution were very satisfactory, the trees treated showing only slight infestation at the end of the season.

EXPERIMENT VIII.

AVENARIUS CARBOLINEUM (APPLIED 1 TO 15 AND 1 TO 20).

This material has been sold for many years by the Carbolineum Wood Preserving Company as a wood preservative and is no doubt a satisfactory solution for that purpose.

From the fact that some parties had been able to secure a good emulsion by the use of this solution with soap, etc., the Company desired to have this emulsion tested to ascertain if it had insecticidal properties, especially in controlling the San José scale. We attempted to carry out their directions and made a fair emulsion, spraying it on twenty-three trees in the orchard. The results of the treatment were very unsatisfactory. There was considerable difference between the two strengths used, but even the stronger wash cannot be considered as an effective treatment.

CHECK PLATS.

Twenty-two trees were reserved in the orchard as checks on the experiments. The scale bred on these trees throughout the summer and they are now in very bad condition.

SUMMARY.

From these tests it appears that all the stronger solutions employed with the exception of San-U-Zay and Avenarius Carbolineum gave good results. These two solutions, even at 1 to 15 strength, did not kill enough scale to justify their use. It may be stated, however, that on account of the limited experiment these results cannot be considered as conclusive.

TABULATED SUMMARY OF RESULTS.

Insecticide used.	Strength.	No. of trees sprayed	Condition of trees before spraying.	Final results in killing scale Sept. 25, 1908.
Lime-sulfur	Regular formula. lime 20 lbs. sulfur 15lbs	29	Badly infested	Very good.
Niagara brand Con. lime-sul.	1 to 12	16	Badly infested	Good.
Niagara brand Con. lime-sul.	1 to 9	10	Badly infested	Very good.
Orchard brand Con. lime-sul.	1 to 12	17	Badly infested	Very good.
Orchard brand Con. lime-sul.	1 to 9	16	Badly infested	Very good.
Rex lime-sulfur	1 to 12	13	Moderately infested	Very good.
Rex lime-sulfur	1 to 9	14	Moderately infested	Excellent.
San-U-Zay	1 to 20	10	Badly infested	Poor.
San-U-Zay	1 to 15	12	Badly infested	Very poor.
Orchard brand soluble oil	1 to 20	16	Badly infested	Good.
Orchard brand soluble oil	1 to 15	19	Badly infested	Very good.
Target brand	1 to 20	14	Moderately infested	Fair.
Target brand	1 to 15	16	Moderately infested	Good.
Avenarius carbolineum	1 to 20	12	Badly infested	Very poor.
Avenarius carbolineum	1 to 15	11	Badly infested	Very poor.
Check		20	Moderately infested	Very scaly.

RECOMMENDATIONS.

Observations of sprayed orchards throughout the State during the past season justify a further discussion of the remedies for the scale. These remedies may generally be divided into two classes: viz, miscible or soluble oils and lime-sulfur compounds.

MISCIBLE OILS.

Since the introduction of these preparations on the market this department has been very conservative in recommending their use. In our experience they have seldom proved satisfactory when used at the strength recommended by the manufacturer and at greater strengths there has been a possibility of injury to trees. While there has been no apparent injury to trees from any of these washes in our experiments, yet serious injury has been reported from the use of two of them the past season on peach trees. The cases of injury were investigated thoroughly and only the character of the parties and the special care taken in making the applications justify this allusion to the matter as a warning to the growers to be on their guard. Injury occurred on peach trees only, but it was so pronounced that care should be exercised in employing such treatment for other kinds of trees. While no doubt these spray mixtures will be more satisfactory on apple than on peach trees, fruit growers should investigate the character of any one of them before using either.

LIME-SULFUR COMPOUNDS.

Manufacturers appreciating the demand for a lime-sulfur wash which can be sold ready for use have placed on the market several brands of concentrated lime-sulfur compounds. Three brands of this solution were included in our experiments this year. The Rex solution was also tested last year. A quantity of the Orchard brand solution has been used by growers in different parts of the State during the past season.

The results of our tests with these solutions on apple and peach were very satisfactory. Observations indicated equally as good results in controlling scale where the concentrated lime-sulfur solution was used by growers. Among the latter, however, there is a difference of opinion as regards the ability of these concentrated solutions to control the peach leaf curl, and their general adoption seems to hang on their fungicidal properties. All that can be said in regard to this aspect of the treatment, is that further experimentation is necessary to clear the question. In our experiment, when the concentrated solution was sprayed on over one hundred trees no curl developed. Also we have a report from a responsible orchardist who sprayed 1256 peach trees seven years old, 700 of which were of the Elberta variety, which generally is subject to injury from leaf curl, and he reports no injury from this disease in spite of the fact that the curl was very bad in his orchard last year. Further this same grower had 100 old Elberta trees in a separate block, 30 of which were sprayed with the solution and these 30 were practically free from curl while the remaining 70 were severely injured by the disease. This would indicate a fair test and the results go to show that the solution will control the leaf curl fungus.

However, considerable injury was observed in another orchard by the leaf curl on trees that had been sprayed with the same solution.

Finally, while the home-made lime-sulfur is considered to be the very best spray solution for the control of the San José scale where circumstances are convenient for its use, yet if it is desired to use a more easily prepared wash, the concentrated lime-sulfur solutions used in our tests seem to offer a favorable substitute for general use, although they are somewhat more expensive.

These solutions at their present strength should be applied at the rate of one part solution to nine parts of water and the addition of a little free slaked lime by the manufacturer or orchardist will be an advantage to the wash.

The method of making the home-made lime-sulfur and also general instructions in spraying and spray pumps have been given so frequently in previous bulletins of this experiment station, which can be had for the asking, that it is not thought necessary to repeat them here.

Fumigation Experiments.

The desire to obtain further information in regard to the fumigation of propagating stock with hydrocyanic acid gas prompted us to conduct a series of tests with young peach buds to observe the effect upon the vitality of the bud as well as upon the scale. These experiments were conducted in two nurseries of the State under conditions as nearly normal as possible.

In the following tables will be shown the different experiments employed, stating the strengths of cyanide used, duration of exposures and the final results.

EXPERIMENT I.

Showing results of fumigating 1310 peach buds with hydrocyanic acid gas at different exposures. Experiment conducted September 7, 1906.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Oct. 13, 1906.		Buds Alive Aug. 30. 1907.	
					No.	Per cent.	No.	Per c.
			grams.					
1.	100	Early Crawford	0.40 and 0.50	30 min.	100	100	73	73
	100	Late Crawford	0.40 and 0.50	30 min.	100	100	65	65
	100	Reeves Favorite	0.40 and 0.50	30 min.	99	99	57	57
	100	Elberta	0.40 and 0.50	30 min.	100	100	63	63
	105	Beers Smock	0.40 and 0.50	30 min.	105	100	58	55.2
2.	160	Late Crawford	0.40 and 0.50	60 min.	159	99.3	87	54.3
	160	Early Crawford	0.40 and 0.50	60 min.	159	99.3	90	56.2
	160	Reeves Favorite	0.40 and 0.50	60 min.	152	95	67	41.8
	160	Elberta	0.40 and 0.50	60 min.	150	93.7	87	54.3
	165	Beers Smock	0.40 and 0.50	60 min.	164	98.7	98	59.3
Check	approximately 750	Elberta	Not fumigated				157	20.9

CONCLUSIONS.

1. It is seen from the above that the excessive amount of 0.50 grams of cyanide per cu. ft. (practically 2 ounces of cyanide to the 100 cu. ft.) will not injure peach buds under ordinary conditions of fumigation, since the average proportion of unfumigated buds which live is only 60 to 65 per cent.

2. That practically no difference was noted in the vitality of the buds exposed in the gas at the above strengths for one hour and those

exposed for half an hour at the first examination October 13, 1906, over a month having elapsed from the time they were budded. The practically 10 per cent difference at the final examination can hardly be attributed to the gas when the check is taken into consideration.

3. That the large per cent of living fumigated buds as compared with the check row is due to other influences than fumigation.

EXPERIMENT I–A.

Showing results of fumigating 2647 peach buds with different strengths of hydrocyanic acid gas at different exposures. Experiment conducted September 1, 1906.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Oct. 9, 1908.		Condition Fall of 1907
					No.	Per ct.	
1.	321	Elberta	0.15 grams	30 min.	137	43.0	The very poor stand due to excessive wet weather in checks as well as throughout the field caused the abandonment of further observations.
	178	Champion			128	71.9	
2.	281	Elberta	0.15 grams	60 min.	161	57.3	
	142	Champion			105	73.8	
3.	188	Elberta	0.18 grams	30 min.	76	40.4	
	104	Champion			48	46.0	
4.	222	Elberta	0.18 grams	60 min.	93	41.9	
	134	Champion			63	47.0	
5.	217	Elberta	0.20 grams	30 min.	81	37.3	
	128	Champion			7	5.5	
6.	231	Elberta	0.20 grams	60 min.	101	43.7	
	168	Champion			52	31.0	
7.	200	Elberta	0.25 grams	30 min.	59	29.0	
	133	Champion			76	57.1	

CONCLUSIONS.

Even under the adverse conditions which befell this block of buds it may be seen that there is no difference in the results from 30 minute, and from one hour exposures, in fact, in every case there were more buds alive from those that were exposed the longer period. Further, no consideration can be taken of the low per cent of living trees from the highest strength of gas as a decidedly smaller number of trees lived in a lower strength of gas, viz, No. 6 which has been the normal strength recommended.

EXPERIMENT II.

Showing results of fumigating 270 peach buds with various strengths of hydrocyanic acid gas, September 7, 1906. All buds were known to be infested with San José scale.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Oct. 13, 1906.		Buds Alive Aug. 30, 1907.		No. of trees infested Aug. 30, 1907.
					No.	Per cent.	No.	Per cent.	
1.	140	Elberta	0.285 grams 0.35 grams 0.40 grams	30 min.	140	100	54	38.5	None
2.	135	Heaths freestone	0.285 grams 0.35 grams 0.40 grams	30 min.	135	100	52	30	None

EXPERIMENT II–A.

Showing results of fumigating 624 peach buds with various strengths of hydrocyanic acid gas, August 27, 1907. All buds except check infested with San José scale.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Sept. 10, 1908.		No. trees infested with scale.
					No.	Per cent.	
1.	167	Late Crawford	0.18 grams	45 min.	90	53.8	None.
2.	240	Late Crawford	0.20 grams	45 min.	137	57.	None.
3.	217	Late Crawford	0.30 grams	45 min.	103	47.4	None.
Check	136	Late Crawford	Not fumigated		71	52.2	

CONCLUSIONS.

1. All the strengths of gas employed were successful in killing the scale.

2. The fumigated buds gave a higher per cent of live trees at final examination than the check, showing that fumigation at the highest strength did not injure the buds in any way.

EXPERIMENT III.

Showing the results of fumigating 500 nursery trees badly infested with San José scale with hydrocyanic acid gas December 4th, 1906. Twenty peach and thirty apple trees were used in each test.

Test No.	Strength of gas per cu. ft.	Duration of exposure.	Condition of trees, Sept. 1907.
1.	0.15 grams	30 min.	Trees showed abundance of living scale.
2.	0.15 grams	60 min.	Trees showed no live scale.
3.	0.20 grams	30 min.	Trees showed few live scale.
4.	0.20 grams	60 min.	No sign of scale.
5.	0.30 grams	30 min.	Live scale found on six trees. All trees vigorous.
6.	0.30 grams	60 min.	No sign of scale found. All trees vigorous.
7.	0.40 grams	30 min.	No sign of scale found. All trees vigorous.
8.	0.40 grams	60 min.	No sign of scale. All trees vigorous.
9.	0.50 grams	30 min.	No sign of scale. All trees vigorous.
10.	0.50 grams	60 min.	No sign of scale. All trees vigorous.

CONCLUSIONS.

1. That fumigation at 0.50 grams cyanide for one hour did not injure trees.

2. That 0.30 grams with 30 minutes exposure is hardly sufficient for fumigating trees known to be infested with scale, and that with this strength a 45 minute exposure should be made in order that the gas may be considered a fairly sure preventive.

EXPERIMENT III–A.

Showing results with 80 nursery trees infested with San José scale fumigated November 2, 1906, with different strengths of hydrocyanic acid gas at different exposures. Ten apple trees were used in each test.

Test No.	Strength of gas per cu. ft.	Duration of exposure.	Condition of trees, July 11, 1907.
1.	0.15 grams	30 min.	Three dead. Live scale found on three trees.
2.	0.15 grams	60 min.	One tree dead. No live scale.
3.	0.20 grams	30 min.	Two trees dead. Scale on one tree.
4.	0.20 grams	60 min.	Four trees dead. No live scale.
5.	0.28 grams	30 min.	Trees all dead.
6.	0.28 grams	60 min.	One tree dead. No live scale.
7.	0.56 grams	30 min.	Six trees dead. No live scale.
8.	0.56 grams	60 min.	Three trees dead. No live scale.

NOTE.—The trees in this experiment were fumigated at the nursery and shipped to College Park. They were delayed on the road and accordingly were not in the best condition for planting upon arrival. For this reason no accurate conclusions can be drawn, but it is seen that no more trees are dead in the test with the highest strength of gas and the longest duration of exposure than in the weakest gas with shortest duration of exposure.

SUMMARY OF FUMIGATION EXPERIMENTS.

The results of these experiments go to show the wisdom of fumigating all buds for propagating purposes with hydrocyanic acid gas by all nurserymen, and that inasmuch as the San José scale may at any time be introduced into a nursery, fumigation with this gas is the best guarantee that the nurseryman can employ against future losses from this pest. Moreover, fumigation with this gas when properly conducted is the best guarantee that the nurseryman can give his patrons in preventing the distribution of the San José scale on nursery stock.

The tests in fumigating buds demonstrate that a much higher strength of gas and longer exposure than is ordinarily recommended, viz, 0.16 to 0.20 grams per cu. ft. can be employed without endangering the vitality of the buds, and that the exposure to the gas even at normal recommended strength for buds should be at least 45 minutes.

In fumigating nursery trees at the normal recommended strength, viz: 1 ounce of cyanide to 100 cu. ft. the duration of exposure should be one hour, and if less time is desired the strength of the gas may be increased with perfect safety to the trees, and insure as far as possible the killing of any scale that may be present.

Experiments in Dipping Nursery Trees.

From time to time during the past two or three years there have been inquiries as to the effectiveness and practicability of dipping nursery trees in lime-sulfur or other spray mixtures as a preventive against the dissemination of San José scale either for the purpose of substituting such treatment for fumigation with hydrocyanic acid gas at the nursery or giving such additional treatment by the orchardist before planting as a further means of killing any scale that may have escaped previous treatment. Some orchardists would prefer dipping in place of fumigation with hydrocyanic acid gas on account of their prejudice against fumigation. But in the light of extended investigations conducted over the country, there is no reason for this prejudice in fearing injury from fumigation with this gas when properly conducted.

The tests have not been as extended as was desired on account of various circumstances, but these results will add to the limited amount of work published on the subject.

EXPERIMENT I.

During March, 1906, 240 dormant nursery trees, 160 apple and 80 peach trees were dipped instantaneously in the lime-sulfur-salt wash formula (20 lime, 15 sulfur and 10 salt to 50 gallons of water, boiled for one hour with steam.)

1. Forty apple and twenty peach were dipped, roots and stems, in the mixture at a temperature of about 170 degrees Fahrenheit.

Results:—At final examination September, 1906, all trees in this lot were dead. Only two had started to grow.

2. Forty apple and twenty peach were dipped, stems only, in the mixture at 170 degrees Fahrenheit.

Results:—The final examination in September showed that all the stems or tops had been scalded and but 23 apple and 16 peach had started at or near the top of the ground and were growing.

3. Forty apple and twenty peach were dipped, roots and stems, in the mixture at a temperature of about 120 degrees Fahrenheit.

Results:—At final examination in September, only 10 apple and 3 peach were alive.

4. Forty apple and twenty peach were dipped, stems only, in the mixture at a temperature of 120 degrees Fahrenheit.

Results:—At final examination in September 30 apple and 19 peach were alive and doing well.

EXPERIMENT II.

On the 27th of April, 1907, sixty-nine apple and peach trees infested with San José scale were dipped instantaneously, tops only, in the home-made lime-sulfur wash at a temperature of 122 degrees Fahrenheit. Also about 100 well grown plants of California privet were dipped, tops only, in the same solution. All stock was planted out the same day as dipped.

Results:—Examination November 29, 1907, showed no injury apparent, as all had grown well. No scale could be found on any of the plants.

EXPERIMENT III.

Showing results of dipping instantaneously salable nursery trees, peach and apple in various spray solutions November 29, 1907. Carolina Red June and Horse varieties of apple, and Bokahra, Belle of Georgia and New Prolific varieties of peach were used in the test.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees October 15, 1908.
Peach 2 Apple 3	5	Scaly	Root and Stem	Lime-sulfur 100° F.	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Lime-sulfur	Good, no scale present	Good, no scale present
Peach 7 Apple 6	13	Clean	Stem only	Lime-sulfur	Good, no scale present	Good, no scale present
Peach 2 Apple 3	5	Clean	Root and stem	Scalecide 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Scalecide 1–15	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Scalecide 1–15	Good, no scale present	Good, no scale present

EXPERIMENT III—Continued.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees Oct. 15, 1908.
Peach 7 Apple 8	15	Clean	Stem only	Scalecide 1–15	Good, no scale present	Good, no scale present
Apple 2 Peach 3	5	Clean	Root and stem	Target brand 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Target brand “	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Target brand “	Good, no scale present	Good, no scale present
Peach 7 Apple 8	15	Clean	Stem only	Target brand “	Good, no scale present	Good, no scale present
Peach 3 Apple 2	5	Clean	Root and stem	Soluble oil 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Soluble-oil 1–15	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Soluble-oil 1–15	Good, no scale present	Good, no scale present
Peach 7 Apple 8	15	Clean	Stem only	Soluble-oil 1–15	Good, no scale present	Good, no scale present
Apple 3 Peach 2	5	Clean	Root and stem	Kilo-scale 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Kilo-scale 1–15	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Kilo-scale 1–51	Good, no scale present	Good, no scale present
Peach 8 Apple 7	15	Clean	Stem only	Kilo-scale 1–15	Good, no scale present	Good, no scale present

CONCLUSIONS.

1. No trees in this test, either those dipped stem only, or root and stem seemed to be injured in any way by any of the solutions, as at this date (October 16, 1908) all trees are in good shape.

2. Careful examination October 16, 1908, of all trees infested with San José scale before dipping shows that all the solutions in this test were effective in killing the scale or preventing its breeding.

EXPERIMENT IV.

Showing results of dipping instantaneously salable nursery trees, peach and apple in various spray solutions April 14 and 16, 1908. Carolina Red, June and Horse varieties of apple and Belle of Georgia and Late Crawford varieties of peach were used in the test.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees Oct. 15, 1908.
Peach 5 Apple 5	10	Clean	Stem only	Lime-sulfur 100° F. 20–15–50	All alive and doing well	No scale present
Peach 4 Apple 4	8	Clean	Root and stem	Lime-sulfur	All vigorous	No scale present
Peach	10	Scaly	Stem only	Lime-sulfur	1 tree dead	No scale present
Peach	10	Scaly	Root and stem	Lime-sulfur	2 trees dead	No scale present
Apple 5 Peach 5	10	Clean	Stem only	Target brand 1–15	2 peach, 1 apple dead; tops of live peach injured	No scale present
Apple 4 Peach 4	8	Clean	Root and stem	Target brand 1–15	1 apple, 1 peach dead; tops of live peach injured	No scale present
Peach 10	10	Scaly	Root and stem	Target brand 1–15	2 trees dead; tops of others very bad	No scale present
Peach	10	Scaly	Stem only	Target brand 1–15	1 tree dead; others serious injured	No scale present
Apple 5 Peach 5	10	Clean	Stem only	Soluble-oil 1–15	1 peach tree dead	No scale present
Apple 4 Peach 4	8	Clean	Root and stem	Soluble-oil 1–15	Condition good	No scale present
Peach	10	Scaly	Root and stem	Soluble-oil 1–15	3 trees with tops injured	No scale. present
Peach 10	10	Scaly	Stem only	Soluble-oil 1–15	4 trees with tops injured	No scale present

EXPERIMENT IV—Continued.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees Oct. 15, 1908.
Apple 4 Peach 4	8	Clean	Stem only	Scalecide 1–15	Tops of all peach and 1 apple badly injured	No scale present
Peach 5 Peach 5	10	Clean	Root and stem	Scalecide 1–15	1 peach dead; tops injured	No scale present
Peach	15	Scaly	Stem only	Scalecide 1–15	1 top dead; others good	No scale present
Peach 10	10	Scaly	Root and stem	Scalecide 1–15	5 tops badly injured	No scale present
Apple 5 Peach 5	10	Clean	Stem only	San-U-Zay 1–15	All dead but two apple	No scale present
Apple 4 Peach 4	8	Clean	Root and stem	San-U-Zay 1–15	All practically dead.	No scale present
Peach 10	10	Scaly	Stem only	San-U-Zay 1–15	All dead	
Peach 5	5	Scaly	Root and Stem	San-U-Zay 1–15	All dead	
Apple 6 Peach 6	12	Check	Not dipped		All alive and thrifty	

CONCLUSIONS.

1. The fact that most of the trees in this experiment were just beginning to leaf when they were dipped, is no doubt the cause for the injury to the tops from the various solutions. However, those used in the tests where no injury is shown were similar to those that were injured. This goes to show that trees should be dipped only when in a completely dormant condition.

2. As in the previous test no live scale could be found at the final examination, October 15, 1908, on the trees that were infested before treatment.

SUMMARY OF DIPPING EXPERIMENTS.

A summary of these experiments shows that dipping dormant nursery trees in the lime-sulfur wash, either stems and roots or stems alone, at a temperature of 172 degrees Fahrenheit, may be expected to be attended by severe injury to the trees and a much lower temperature would be desirable if the effect upon the health of the trees alone could be considered. In the first experiment considerable difference is noted in dipping roots and stems and stems alone in the solution at 172 degrees Fahrenheit. In the succeeding experiments practically no difference could be detected between those immersed stems and roots or stems alone in the lime-sulfur solution at 100 degrees Fahrenheit or other solutions employed, with possibly the exception of some miscible oils. We believe, however, the dipping of the roots of trees in any of these solutions to be rather a questionable procedure and not a safe treatment for the trees.

The results as indicated in experiments two, three and four go to show that dormant nursery trees may be dipped instantaneously stems or tops only in the lime-sulfur wash at or below the temperature of 100 degrees Fahrenheit and in the various miscible oils employed in our tests without apparent injury resulting to the trees. They also show that only strictly dormant nursery stock should be dipped in any of the solutions used.

These experiments further indicate that such treatment may be considered effective in combating the San José scale, as in all the tests where infested trees were dipped no live scale could be found on the trees at the final examination. However, the published results of other experimenters and the limited number of infested trees included in these tests, lead us to consider that these results may be inconclusive.

These varying results go to show that further experimentation is necessary in order to establish what may be expected from such treatment before its adoption for general use becomes desirable.

PRACTICABILITY OF DIPPING TREES.

Even if the dipping of salable trees in the dormant state should prove a safe treatment in preventing the distribution of San José scale, and though subsequent experimentation should thoroughly establish such treatment to be unattended by injury to trees, the practicability of its use by nurserymen as a substitute for fumigation is questionable. Obviously the dipping of all trees before shipment would be a more laborious task than fumigation, in addition to the unfavorable condition of the trees for handling after such treatment.

The question of expense should also be considered, for there is no doubt that such treatment would be an added expense to the nurserymen. Moreover, no matter what further experimentation may develop, there would always be the possibility of injury to trees when subjected to such treatment by careless laborers. While this latter objection is equally true with fumigation with hydrocyanic acid gas the nurserymen have long realized the importance of placing the fumigation of stock in the hands of one responsible person. Nor can we point out any advantage from dipping nursery stock by the orchardist before planting inasmuch as the law requires the fumigation with hydrocyanic acid gas of all deciduous stock before shipment, and as this treatment is the surest guarantee that the nurseryman can give the orchardist that the scale or other pest, that by chance may be present, is killed, there is no need of subjecting the trees to other treatment before planting. Moreover, when trees arrive at their destination in spring they often have started to leaf or at least the buds have begun to swell and open and as we have seen, dipping trees in any solution when they are in this condition is liable to be attended with injury.

The expense and especially the inconvenience of handling nursery stock after dipping would be as troublesome to the orchardist as it would be to the nurseryman. In addition subjecting the trees to this unnecessary treatment would afford another opportunity for undue exposure of the roots of the trees which is no doubt a cause of the death of a large per cent of the trees that fail to grow.

Finally, we do not recommend dipping salable nursery trees in any solution until further experimentation shall have been conducted in order to more thoroughly establish the effect of such treatment upon the trees and scale, and even if such treatment should ultimately prove efficacious we do not believe its substitution for fumigation with hydrocyanic acid gas desirable under present conditions.

Public Sprayers.

In Bulletin 123 of this experiment station attention was directed to the great need of public spraying outfits in various parts of the state, especially in localities where fruit trees are grown by the farmers for home use only and around our cities, towns and villages where a few trees only are grown by suburbanites for the same purpose. Among this class of people there is not sufficient interest at stake ordinarily to justify their procuring spraying apparatus properly to treat a half dozen or so trees, but they are usually sufficiently eager to have their trees healthful and will willingly employ a public spraying outfit to treat such trees effectively, especially where the trees are infested with San José scale. Indeed it may be stated that the prevalence of this pest on fruit trees in our towns and villages and the desire of furnishing a means of control was the principal incentive to inaugurate this work.

In order to demonstrate the field for a successful business to the end of inducing private parties to take up the work, this Department established ten public spraying outfits in different parts of the State during the past season. Each outfit consisted of a small boiler and barrel spray pump and accessories. A responsible man was secured to superintend each outfit. The spraying was conducted on a basis of cost of operation and not with any desire to make a profit for the Department. Fortunately, the practical operation of these spraying outfits was attended with success in each locality where established. In nearly all the districts there was more work than the outfits could accomplish prior to the opening of buds which prevented spraying with a wash for dormant trees only. One rig, however, was operated late in the spring, a spray being applied to control the codling moth.

As a result of this so-called demonstration work arrangements we understand, have been perfected, whereby private parties will conduct public sprayers in at least three different parts of the State this coming fall and spring and it is hoped others will realize the opportunity for remunerative employment from the proper operation of such a business.

This department has received many favorable comments from persons whose trees and shrubs have been benefited by the spraying and also requests from many persons for the location of public sprayers in their respective localities. Our limited funds will permit of only a certain amount of such extension or demonstrative work but we stand ready to aid all parties and localities in so far as our means will allow. It is firmly believed that such demonstrative work is of paramount importance in the dissemination of information that will lead to a better understanding and a more vigorous control of our injurious insect pests.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 132 FEBRUARY, 1909

IRISH POTATO INVESTIGATIONS

By C. P. Close and T. H. White

INTRODUCTION

The work reported on in this Bulletin was started in 1901. Some of the experiments point so consistently in one direction that the results may be considered conclusive. Others will be continued with the hope that something further may be learned.

The cultural tests which were conducted during the years 1901 to 1904, inclusive, were planned by W. T. L. Taliaferro, professor of agriculture. The details were looked after and the records kept by E. O. Garner, farm superintendent, from whose books the results and averages have been worked out.

The collection of varieties was secured from abroad, and from other states, in the spring of 1905, by W. N. Hutt, who was then professor of horticulture, for the purpose of selection and cross breeding, which was to have been conducted by S. B. Shaw. Mr. Shaw resigned before much had been done along this line and the experiment work from that time has been in charge of Thos. H. White, who has observed and investigated the various lines of work reported herein.

THE PURPOSE OF THE EXPERIMENTS

1. Cultural experiments to ascertain whether shallow, medium, or deep culture, at intervals of five, ten or fifteen days, would produce the best crop.
2. To determine the relative yields from seed grown in Maryland, in Maine, and as "second crop" in Virginia.

3. To determine if cold storage seed with sprouting retarded, is better than ordinary storage with seed sprouted.
4. To notice what would be the difference in yield between crops resulting from tubers having very weak sprouts, and tubers of the same lot having strong sprouts.
5. To test the value of seed potatoes grown early and harvested in summer, versus the fall grown crop.
6. To note the difference in yield from eyes taken from the base, or stem end, and those from the terminal, or seed end, of tubers grown in Maine, and the summer grown seed of Maryland.
7. To test the productiveness of fall harvested tubers from the largest, or egg-size, down to the smallest, or marble-size.
8. To test varieties of American, French and German origin.

CULTURAL EXPERIMENTS

This was conducted four seasons and the plan was to divide a suitable piece of land into three sections. These sections were cultivated shallow, medium, and deep. All sections were treated exactly alike until the first cultivation when each section was sub-divided for the five, ten and fifteen day interval cultivations.

This altogether made nine plots which were treated as follows:

Plot 1. Shallow cultivation every five days.
Plot 2. Shallow cultivation every ten days.
Plot 3. Shallow cultivation every fifteen days.
Plot 4. Medium deep cultivation every five days.
Plot 5. Medium deep cultivation every ten days.
Plot 6. Medium deep cultivation every fifteen days.
Plot 7. Deep cultivation every five days.
Plot 8. Deep Cultivation every ten days.
Plot 9. Deep cultivation every fifteen days.

Rainy weather occasionally delayed cultivation a day or two.

The shallow cultivation was done with a Keystone weeder which simply scratched the surface.

The medium deep cultivation was done by a Planet Junior fourteen toothed harrow cultivator, with a wheel in front and a leveling or smoothing device at the back. The depth was regulated as nearly as possible to two and one-half inches.

The deep cultivation was done with an "Iron Age" five shovel cultivator regulated to a depth of five inches.

The number of cultivations was six, four, and two for the five day, ten day, and fifteen day interval cultivations respectively.

Table I on page 154 shows the yield in bushels per acre of primes and culls from shallow, medium and deep cultivation, at five, ten and fifteen day intervals. Primes include all merchantable potatoes.

From table I the following sets of figures are obtained to show the average of yields as affected by depth of cultivation, disregarding the number of times cultivated.

SURFACE		MEDIUM DEEP		DEEP	
Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls
127.3	30.0	137.9	30.3	141.6	28.2

And also the average of yields as affected by frequency of cultivation, disregarding depth.

FIVE DAYS		TEN DAYS		FIFTEEN DAYS	
Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls
126.5	27.4	132.4	27.6	147.5	33.2

The above figures seem to clearly indicate that the deep and infrequent cultivation was most profitable, there being a difference of more than fourteen bushels per acre in favor of the deep over the shallow cultivation, and of twenty-one bushels in favor of infrequent working. It would seem, therefore, that the practice of farmers who usually cultivate with such tools and at such times as will keep the crop free from weeds, is about all that is necessary to produce a good crop under the conditions prevailing here. The result may have been different if the same experiment had been conducted in the arid West. It is only at rare intervals that the rainfall in Maryland is so slight that it is practicable or necessary to work for a "dust mulch." What is really important is to destroy the weeds and stir the soil fairly deep to aërate, and at the same time dry it, and make it loose and friable.

YIELDS FROM SEED GROWN IN MAINE, MARYLAND AND VIRGINIA

It is the practice of specialists in potatoes in this state not to depend upon home grown summer harvested seed for the next crop. They have found that while the tubers might be at least as numerous, they

TABLE I

Shows yield of primes and culls in bushels per acre on the nine plots for four years, and the average yield per acre of each plot.

SEASON	PLOT 1		PLOT 2		PLOT 3		PLOT 4		PLOT 5		PLOT 6		PLOT 7		PLOT 8		PLOT 9	
	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
1900 ...	194.7	30.5	148.6	31.0	257.9	39.9	209.4	26.3	210.3	31.8	189.3	35.6	220.2	30.4	284.2	33.2	218.6	34.6
1901*.....	89.1	52.7	148.2	54.3	134.4	65.3	105.9	69.7	134.4	58.9	189.0	78.6	98.0	58.3	85.8	52.7	191.2	70.1
1901*.....	71.4	3.0	76.5	3.0	98.2	4.0	72.8	3.1	84.1	4.3	88.2	5.7	64.2	2.3	83.2	3.1	67.1	6.9
1902......	119.4	23.2	87.5	25.6	143.5	31.4	130.0	24.7	119.8	26.1	141.2	33.7	129.1	21.7	138.7	31.9	111.0	32.0
1904......	104.4	23.0	125.6	32.5	120.8	32.7	138.6	28.1	122.6	14.9	135.5	13.8	152.4	15.4	141.0	16.5	138.4	15.1
Average...	115.8	26.4	116.6	29.2	149.7	34.6	131.3	30.3	134.2	27.2	148.2	33.4	132.6	25.6	146.5	27.4	145.7	31.7

* Two crops, one early and one late, were grown in 1901.

would not be so large or so regular in maturing. It was soon discovered that seed produced in Aroostook county, Maine, was about the best that could be procured. This county is in the extreme northern part of Maine and the summer season is short and cool. At the same time it was found that about as good a yield could be obtained from seed that had been grown by planting the small tubers of the early dug crop, and which under favorable conditions would make fair sized tubers late in the fall.

This method of producing seed can be conducted with very good results on the eastern shore of Maryland, and in some sections of Virginia.

It was to test the relative value of seed from these sources that the tests were commenced in the year 1900.

Table II shows the relative yields of home grown summer harvested seed, Maine grown seed, Virginia second crop seed, and Maryland second crop seed, in bushels per acre for six years.

TABLE II

Shows yield of primes and culls for seven years from Maine grown, Maryland early crop, Virginia second crop, and Maryland second crop seed.

VARIETIES	YEAR	MAINE GROWN		MARYLAND EARLY CROP		VIRGINIA SECOND CROP		MARYLAND SECOND CROP	
		Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Early Rose.....	1900	173.8	49.9	99.1	59.4	150.3	44.2	177.1	45.5
Early Rose.....	1901	63.8	22.4			106.3	23.0		
Crown Jewel....	1902	147.0	22.0					174.8	15.0
Early Rose.....	1903	107.2	12.8			106.8	10.4		
Irish Cobbler...	1907	123.3	90.7	111.3	78.3				
Early Rose.....	1908	93.4	35.4	98.3	34.8	72.9	38.7		
Triumph.......	1908	122.2	50.8	100.1	44.2	67.4	39.5		
Bovee..........	1908	87.1	33.7	50.8	23.9	60.5	31.3		
Sir Walter Raleigh......	1908	74.7	77.5	91.4	31.2				
Average......		110.2	43.9	91.8	45.3	94.0	31.1	175.9	30.2

A study of the above table shows that for the two seasons the Maryland second crop seed was grown, it gave the best yield. The Maine grown seed was next best, with the Virginia second crop, and home grown summer-harvested, last in the order named. By taking an average of all the varieties through the several seasons, the Maine grown are nineteen bushels better than the home grown, and sixteen bushels better than the Virginia second crop. As all large tubers were used in the test with the home grown lot, it would evidently be more profitable to sell these and save the trouble and expense of storing, and buy Maine grown, or second crop seed.

ORDINARY AND COLD STORAGE SEED POTATOES

The general opinion prevails that the superiority of the Maine grown and second crop seed is due to the fact that the crop is harvested later in the fall and the tubers do not sprout and exhaust themselves as much as the early harvested crop. It would seem, therefore, if such is the case, that stock packed in cold storage as soon as dug, should be in prime condition, in this respect, for planting in spring.

For this test a peck each of four varieties were sent to cold storage. August 30, 1905. A similar lot was stored in a vault which is cool in summer and frostproof in winter. They were left without disturbance until May 20, 1906, when both lots were planted. The cold storage lot were quite firm and solid and had made no signs of sprouting. The ordinary or vault stored lot had sprouted considerably.

In cutting them for planting, no attempt was made to rub off these sprouts, the tubers were simply cut to two eyes and dropped in the row. The ordinary stored lots came up first, but after a couple of weeks no difference could be detected between the two lots.

Table III shows the difference in yields between ordinary storage and cold storage seed calculated to bushels per acre.

TABLE III

Shows yield in bushels per acre of primes and culls from seed kept in cold storage, and seed kept in ordinary storage.

VARIETIES	COLD STORAGE		ORDINARY STORAGE	
	Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls
Early Rose	81.3	34.9	99.4	39.3
Manistee	90.0	23.2	94.5	45.0
Sunlight	139.2	50.8	113.9	79.1
Clark's Pride	142.1	82.7	139.2	73.2
Average	113.1	47.9	111.7	59.1

The difference in the yields between these methods of storing is ten bushels in favor of ordinary storage. From this one test it does not appear that cold storage would be of very much importance in keeping seed potatoes, when they are to be planted in the early spring.

EXPERIMENTS WITH TUBERS SHOWING WEAK SPROUTS VERSUS OTHERS SHOWING STRONG SPROUTS

It was noticed when planting the variety potatoes which were home grown and harvested in the summer, that many of the varieties had some tubers which were starting with very weak sprouts. It at first looked as though this might be due to absence of light, but upon further investigation, it was seen that this was not the case, for strong vigorous sprouts could be found under the same conditions as the weak ones. In fact both kinds could sometimes be found on the same potato.

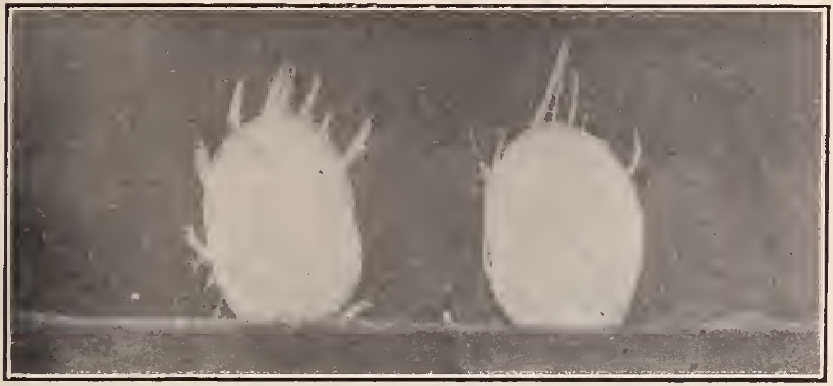


Fig. 1 Potatoes showing the characteristic "strong" and "weak" sprouts. Weak sprouts on the right.

It seemed as though this might be the cause for home grown seed not producing as well as the Maine seed, which always had strong sprouts. Some of the weak sprouted tubers were planted in a separate row alongside of the strong sprouted tubers from the same lot. The tops of the former were weak during the entire season, while the tops of the latter were strong. See figures 1, 2, 3 and 4.

The amount of the yields of the different varieties was in direct relation to the size of the tops as shown in table IV.

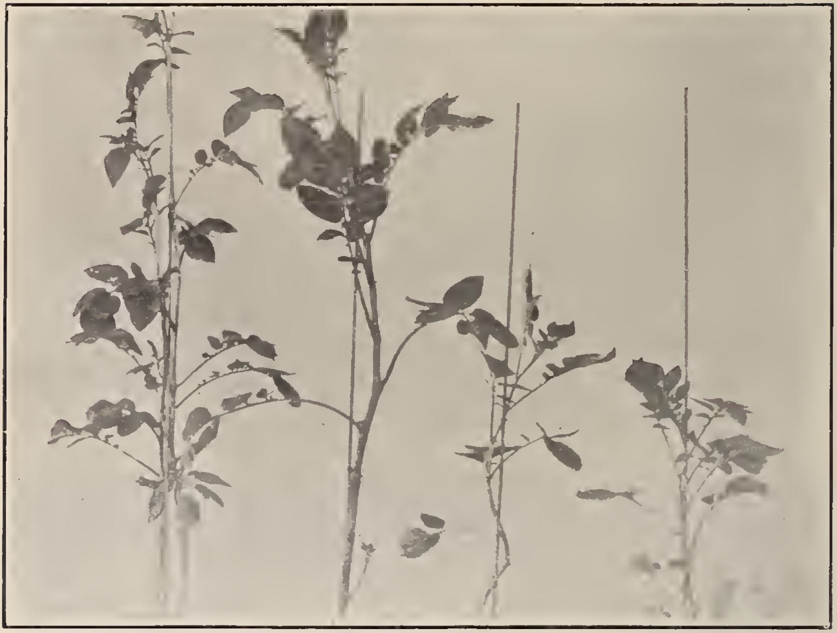


Fig. 2 Plants grown from strong and weak sprouts. Weak sprouts on the right.

Fig. 3 Shows growth of vines from "strong" and "weak" sprout seed. Row marked with a white stake is from weak sprouts.

TABLE IV

Shows yield of primes and culls in bushels per acre from seed with strong sprouts and seed with weak sprouts.

VARIETIES	YEAR	STRONG SPROUTS		WEAK SPROUTS	
		Primes	Culls	Primes	Culls
Early Rose	1907	165.3	107.4	83.2	65.8
Early Michigan	1907	54.2	53.0	21.0	41.3
Triumph	1908	100.1	44.2	59.1	44.2
Sir Walter Raleigh	1908	91.4	31.2	15.3	14.2
Early Rose	1908	93.3	34.8	9.4	18.8
Average		126.0	54.1	37.6	36.8

The above figures show convincingly that it is very necessary to start with a good strong germ or sprout.

The cause for the weak sprouts, is not so apparent. A plausible theory would be that owing to the heat of mid-summer the tuber fails to properly store up the right material for the next year's supply of nourishment to the eye or germ, or it may be a disease that affects the plant under those conditions. A somewhat similar trouble has been noticed in dahlias, and the Easter lily is notorious for a similar weakness.

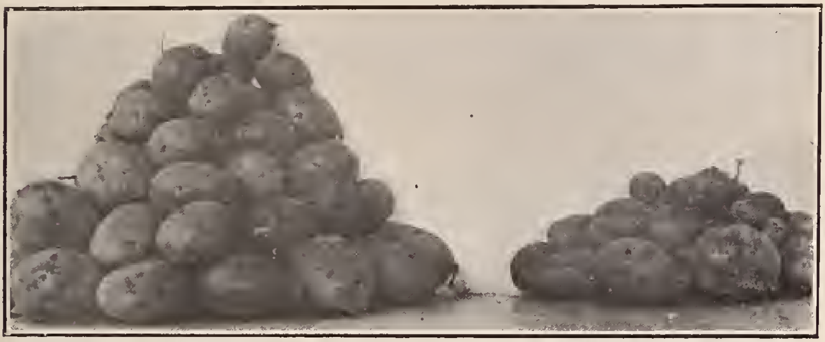


Fig. 4 Shows yield from strong and weak sprouts. Weak sprouts yield on the right.

SEED FROM EARLY PLANTED VERSUS FALL GROWN CROP

Since cool weather seemed necessary for the production of strong germs for producing a good crop the following year, it was thought practicable to produce good seed by delaying planting until the first of August and thus have the crop for next year make its growth in cool weather. This was done in 1906 and again in 1907. The experiment was only a partial success from the fact that the tops died off too soon in the fall, thus defeating the object of having the tubers form in the cool fall weather. The tubers did not grow large, the largest being about the average size of a hen's egg and the smallest the size of a small marble.

In 1907 the seed was planted the first of September. It was hoped by this late planting that the vines would keep green until late fall. This proved to be the case, but an early frost cut the tops at such an early stage of the plants' growth, that no tubers of any account were harvested.

For this reason only two seasons' yields of this experiment are on record, as is shown in table V.

TABLE V

Shows the yield of primes and culls in bushels per acre from summer and fall harvested seed.

VARIETIES 1906	SUMMER		FALL	
	Primes	Culls	Primes	Culls
Red River Acme	83.4	29.0	117.4	40.6
Rural New-Yorker	50.7	43.5	152.3	14.0
Early Rose	99.2	39.3	156.6	26.1
Bovee	81.2	47.8	66.7	23.2
Manistee	95.8	45.8	184.1	43.0
Early Market	84.6	36.5	153.7	14.5
Early Michigan	52.9	39.8	106.4	30.9
Sir Walter Raleigh	148.0	37.0	124.8	34.8
1907				
Red River Early Ohio	144.1	23.9	133.4	20.3
Green Mountain	278.0	53.6	284.2	17.4
Red River Triumph	97.1	84.1	112.9	60.9
Manistee	211.7	73.9	159.5	55.1
Home White Ohio	66.7	47.6	139.2	31.9
Red River Acme	71.0	65.2	101.5	43.5
Average	111.7	47.6	142.4	32.4

The table shows that the yields on the average are in favor of the fall harvested seed. It is reasonably certain, however, that if the plants could have been kept growing so that the tubers would have formed late in the fall, there would have been a greater difference.

The crop of tubers when grown by either of these methods is usually small in size. It is, therefore, very necessary to make use of all regardless of size, if they will produce a good crop.

In order to determine the difference between the yields of the several sizes, selections were made and planted in separate rows.

These were graded as egg size, walnut size, and marble size. The yields of the different sized seed tubers in bushels per acre were as follows:

VARIETIES	EGG SIZE		WALNUT SIZE		MARBLE SIZE	
	Primes	Culls	Primes	Culls	Primes	Culls
Green Mountain	284.2	17.4	185.4	23.2	164.4	47.7
Irish Cobbler	90.2	79.2	69.6	33.6	52.8	31.2

The difference in yield is in favor of the larger tubers. This was to be expected. It was remarkable, however, that the small marble sized potatoes yielded so well. Part of the increase in yield of the larger sized seed, was due to a much better stand.

The marble sized tubers usually had but one eye, and if the sprout from this was destroyed there was nothing to replace it.

The egg size tubers had from three to six eyes, thus having a better chance to replace any damaged germs.

Figure 5 shows a photograph of fall harvested tubers as planted the next spring.

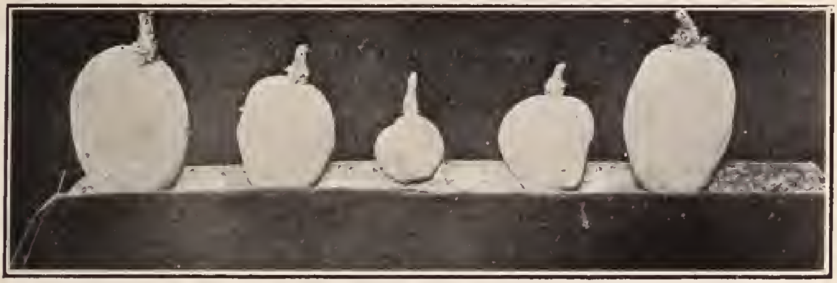


Fig. 5 Shows sample of Fall harvested tubers. Egg size, walnut size and marble size. Note uniformity of size of sprouts

DIFFERENCE IN YIELD BETWEEN EYES CUT FROM BASE AND TERMINAL ENDS

The inspiration for this experiment grew out of several important facts observed in conducting the foregoing work.

It was noticed that the large tubers of the Maine grown seed always start earliest and strongest at the seed or terminal end. See figure 6. These eyes being the last produced would have been developed during the cool weather of the fall.

On the other hand, in several varieties of the home grown summer harvested seed, the earliest and strongest development was at the base or stem end. See figure 7. These would have formed late in May or early in June when the weather was cooler than mid-summer. Theoretically, then, the base eyes of the home grown potatoes and the terminal eyes of the Maine grown potatoes, should produce the best crop. To test this, several long shaped tubers were selected of the varieties Early Rose and Sir Walter Raleigh, Maine grown and home grown seed. These were cut across the center dividing the base and terminal eyes. The pieces were then cut so that two eyes were left to the piece and each lot was planted in separate rows. The growth and yield were about as was expected and the yield is shown in table VI.

TABLE VI

Shows the yield in bushels of primes and culls per acre of the seed end and stem end of Maine grown and home grown seed.

VARIETIES	MAINE GROWN				HOME GROWN			
	SEED END		STEM END		SEED END		STEM END	
	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Early Rose	108.9	26.6	78.7	44.2	74.7	36.3	121.9	33.3
Sir Walter Raleigh.......	82.3	29.6	67.5	25.4	84.2	25.4	95.1	38.4
Average..............	95.6	23.1	72.5	34.8	79.4	30.8	108.5	35.8

This table shows that with the Maine seed the seed end surpassed the stem end yield by 22 and 19 bushels per acre respectively in the order of the varieties given. Likewise the yield of the stem end of the home grown seed exceeded that of the seed end by 44 and 24 bushels per acre respectively.

It may also be noted that the home grown seed produced a larger yield than Maine grown seed.

EXPERIMENT WITH VARIETIES

The primary object of this experiment was to obtain better varieties.

About the time that this work was started the McCormick had been grown for several seasons and had proved a very vigorous, hardy variety and fairly resistant to both blight and beetles. It was also a good cropper. About the only thing against it was its poor quality, especially on some soils. The general opinion was that this variety originally came from Germany. It was thought that perhaps some superior varieties might be found among new importations. Twenty-seven American varieties of northern grown seed, seventeen varieties of French, and eight varieties of German seed were planted in the spring of 1905. To these were added twenty-one varieties in the spring of 1906.

This latter lot were varieties which had been displayed in the State Horticultural Society exhibit and were grown in the western counties of Maryland.

The planting was all done the same day under the same conditions and a different plot of land was selected each season. The planting was done on May 4 in 1905; on May 2 in 1906; on April 14 in 1907; and on April 20 in 1908. The yields of the varieties for the different years and the average yield for that time are given in table VII.

A study of the annual yields as shown by the table will reveal many peculiarities. It shows how inconsistently the different varieties act year after year. This is no doubt due to the varying seasons. A spell of dry weather, or, on the other hand, a good rain, may happen to be just right for the development of one variety and would be too soon or too late for another.

On the whole, it will perhaps be best to depend upon the total average yields as shown in the table. Of the early varieties, or those maturing the first to second week in July, it appears that Irish Cobbler is the best yielder with Noroton Beauty, Clark's Pride, Early Ohio and Early Sixweeks, next best in the order named. These are generally considered good varieties and will evidently do very well under the conditions prevailing here.

With regard to the medium maturing varieties, or those which mature one or two weeks later, Green Mountain stands first and is followed by Rural New-Yorker, Planet, Sir Walter Raleigh, Early Thoroughbred, Early Reliance, Pat's Choice, Montana Prizetaker, White Elephant,

TABLE VII

Shows yield of primes and culls in bushels per acre and the average yield for four years, and the origin of the varieties

VARIETIES	ORIGIN	1905		1906		1907		1908		AVERAGE	
		Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Early Maturing.											
Early Ohio	Am.	142.6	6.5	143.6	36.2	46.1	67.5	82.2	43.5	103.6	53.4
Triumph or Red Bliss	Am.	100.1	18.5	58.6	36.5	97.5	83.6	100.1	44.2	86.5	45.7
Irish Cobbler	Am.	210.3	40.6	109.6	56.5	111.3	78.3	116.0	43.5	136.7	53.9
Home White Ohio	Am.	210.1	43.5	115.6	37.0	66.8	48.6	50.8	38.4	85.8	16.8
Noroton Beauty	Am.			146.8	57.9	132.8	105.6	90.7	74.7	123.4	79.4
Early Six Weeks	Am.			141.6	47.9	55.3	78.3	113.2	31.2	103.3	52.4
Maggie Murphy	Am.			102.3	43.5	80.3	78.3	112.0	31.2	98.2	50.6
Red River Acme	Am.	114.3	32.5	83.8	29.3	70.8	64.9	62.4	29.6	82.8	39.0
Extra Early Eureka	Am.	115.6	55.6	47.2	26.1	108.8	69.2	96.3	36.3	92.0	46.8
Early Market	Am.	201.6	24.6	84.6	36.5	42.3	35.4	58.8	31.0	103.3	31.6
Clark's Pride	Am.	150.8	31.9	139.9	73.3	53.3	68.9	101.5	43.5	113.3	54.4
Bonne des Bonnes	Fr.	75.0	41.2	77.0	18.5	123.3	83.8	67.5	18.8	60.2	40.5
Uncle Gideon's Quick Lunch	Am.	58.8	11.6	52.6	58.6	165.0	61.0	74.9	43.5	87.7	43.6
Medium Maturing.											
Early Rose	Am.	209.0	50.8	99.2	39.3	55.6	75.5	98.3	34.8	115.7	48.6
Sixweeks	Am.	137.8	31.9	64.8	45.5	97.2	73.3	58.8	43.5	199.5	64.7
Early Reliance	Am.			196.6	63.2	104.5	92.8	84.2	42.4	128.4	66.1
White Elephant	Am.			174.1	21.0	113.2	49.4	87.1	38.4	124.8	36.2
Planet	Am.			258.1	63.9	113.2	73.3	96.5	37.0	155.6	58.0
State of Maine	Am.			101.9	33.3	165.0	63.9	98.2	31.2	121.7	42.8
Rural New Yorker	Am.	207.6	33.8	50.8	50.6	113.2	36.8	96.5	29.7	156.0	50.3
Ionia Seedling	Am.	48.6	14.5	69.7	17.3	99.2	72.6	91.4	34.8	102.9	46.4
Pat's Choice	Am.	165.0	10.9	137.9	57.6	92.8	68.3	110.7	29.7	126.6	41.6
Early Thoroughbred	Am.			293.6	55.6	20.2	70.8	82.3	34.8	132.0	50.0
Early Jersey	Am.			136.5	60.4	111.0	95.8	84.2	39.5	110.5	65.2
Green Mountain	Am.			301.6	12.3	278.6	53.7	61.7	33.3	213.9	33.1
Carman No. 1	Am.			67.9	145.6	168.2	116.3	73.3	34.8	103.1	98.9
Montana Prizetaker	Am.	184.6	26.2	66.8	90.0	130.2	87.1	116.9	39.5	124.6	60.7
Manistee	Am.	95.7	37.8	95.8	45.8	211.6	73.3	70.3	31.2	118.5	47.0
Pingree	Am.			108.9	75.5	55.6	75.5	105.9	31.0	90.1	60.6
Min. Von Miguel	Ger.	113.2	48.8	43.3	75.5	63.8	116.3	72.0	39.5	73.2	70.0
Fornheim	Am.	124.6	50.8	72.6	69.6	59.3	104.6	74.7	36.3	85.3	65.2
World's Fair	Am.	37.5	15.9	71.8	97.2	109.6	107.4	65.3	31.0	70.5	62.8
Crines Lighting	Am.	59.3	10.1	118.9	50.6	107.0	52.2	110.8	26.6	99.0	34.8
Le Milleure de Belleville	Fr.	30.8	14.5	20.3	14.8	95.7	63.9	73.3	22.2	55.0	28.7
Bovee	Am.	137.8	46.4	75.3	47.9	49.3	56.0	50.8	23.9	78.3	43.5
Sir Walter Raleigh	Am.	204.0	37.8	148.0	37.0	127.6	87.1	91.4	31.2	142.7	48.2
Early Michigan	Am.			52.9	39.8	37.8	49.4	76.3	40.6	55.3	43.2
Late Maturing.											
The Clinton	Am.	101.9	18.9	103.2	18.9	107.8	56.5	52.9	13.2	182.9	53.7
Constellation	Fr.	55.6	19.4		78.3		127.0	40.6	58.0	24.0	70.6
Eiffel Tardive	Fr.	24.6	18.9	14.5	55.6	46.4	143.6	18.8	14.5	26.0	58.1
Agnelli	Fr.	113.0	27.5	67.5	111.2	204.4	104.0	90.7	14.5	118.9	64.3
La Czarina	Fr.	31.9	2.3	28.3	4.7	33.3	20.2		33.3	23.4	15.1
Dr. Von Ecken Becker	Ger.	84.6	21.9	91.5	63.9	150.9	70.7	91.4	10.9	99.6	41.8

TABLE VII—*Continued.*

VARIETIES	ORIGIN	1905		1906		1907		1908		AVERAGE	
		Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Late Maturing.											
Graminee	Ger.	78.3	8.8	40.6	28.3	168.2	70.8		34.8	71.7	36.1
Professor Maerker	Ger.	49.4	28.2		41.3	63.9	78.3	23.9	33.2	42.7	37.3
Ed. Lefort	Fr.	78.3	21.7		15.9		69.7	24.2	13.2	25.1	30.1
Bund der Landwirt	Ger.	77.0	15.9	41.3	30.5	90.0	91.7	44.2	12.0	63.1	37.5
Jardiniere	Fr.	80.3	24.6		41.0	54.2	56.5	18.8	18.8	38.5	35.2
Pouisse Debout	Fr.	49.4	20.3	36.8	36.2	46.4	77.2		34.8	32.6	42.1
Duchesse	Fr.	78.3	49.4	90.7	57.6	179.8	70.8	72.6	15.7	105.3	48.1
Farineuse Rouge	Fr.	56.8	8.8		20.3	109.5	36.2	43.5	12.5	38.5	19.4
Professor Jules Kuhn	Ger.	46.8	36.8		26.1		233.8		58.0	11.7	88.6
Canada	Fr.	233.0	50.8	90.0	15.9	139.0	99.8	101.8	29.7	140.9	48.5
Leo	Fr.	79.1	11.3	32.5	90.0	165.0	97.9	103.9	14.5	95.1	53.4
Geheimrath Thiel	Ger.	52.2	30.5		23.2	49.7	121.2	70.3	38.4	43.0	53.3
Prolific Tardive	Fr.	122.9	17.4	47.9	87.8	107.3	45.8	68.7	12.5	86.7	40.8
Professor Wohltmann	Ger.	56.5	21.7		107.4	101.9	110.8	15.0	22.2	43.3	65.5
Vigorosa	Fr.	82.0	11.3	46.6	88.5	113.2	69.6	40.6	12.0	70.6	45.2
Fleur de Pecher	Fr.	62.1	33.3	5.8	61.0	132.0	113.2	33.3	23.9	58.3	57.7
Carola	Fr.		15.8		8.8	46.4	34.9	76.7	38.4	30.7	24.1
Magnum Bonum	Fr.	58.0	37.6		15.9		49.4	23.3	25.1	2.3	32.8
Livingston	Am.	20.7	26.2	132.0	50.8	101.9	54.2	19.2	7.9	68.4	34.2
McCormick	Am.	77.0	31.9	123.2	124.5	165.0	107.3	130.6	88.9	123.9	88.1
Banner	Am.	129.5	20.2	145.0	43.8	83.8	60.9	108.9	14.5	116.3	34.9
Peach Blow	Am.			37.8	13.6	83.3	36.2	65.7	79.8	62.2	43.6
Mark Hanna	Am.			75.3	36.8	127.7	72.6	56.6	7.9	53.2	39.0
Oom Paul	Am.			182.9	122.7	95.8	95.7	73.3	33.3	117.3	83.3
Pride of America	Am.			159.9	40.6	118.9	70.8	98.2	29.7	125.6	11.8
Uncle Sam	Am.			116.8	43.8	66.8	63.9	90.7	33.3	91.4	47.4
Blush	Am.			77.0	40.6	284.6	60.9	186.6	72.6	182.7	58.0
Commercial	Am.			123.2	43.8	83.8	60.9	108.9	27.3	105.3	44.0
Blue Peerless	Am.			219.8	20.3	233.8	90.7	115.8	29.7	189.8	46.9
No Bug	Am.			34.9	43.8	122.0	70.8	88.9	23.9	81.9	49.4
Solanum Commersonii					53.6	122.7	56.0	50.8	14.5	57.8	41.3

State of Maine, Sixweeks, Manistee and Early Rose in the order named.

Of the later maturing varieties the Blue Peerless heads the list, with Blush, Clinton, Canada Pride of America, McCormick, Oom Paul, Agnelli, and Banner following. It was expected that the McCormick would make a better showing as it is considered a wonderful cropper. It would perhaps show up better in competition if planted late.

None of the German or French varieties were notable in any way to make them valuable here.

REVIEW AND CONCLUSIONS

It seems safe to assume that working potatoes with a five shoveled horse cultivator about twice or three times, is good practice for conditions such as prevailed here. The Maine grown seed potatoes always produced better yields than home grown seed. From the experiments that bear upon this phase of the question, it would seem that it is not so much where the seed is grown as it is a question of climatic conditions. In other words, the best condition for the development of a strong germ, is cool weather, and a strong germ is one of the necessities for a good crop. Varieties like Early Ohio and Red River Acme that form their tubers early in the summer, or late planted Blush and McCormick that form tubers late in the fall, can be planted year after year without apparent deterioration. For the same reason the eyes from the base or stem end of the home grown largestsized tubers, produced better than the terminal or seed end. And the seed or terminal end of the Maine grown did better than the base or stem end.

In this locality the base eyes of the largest tubers of varieties like Early Rose or Sir Walter Raleigh are in process of formation in early summer, while the seed end is the last to form in mid-summer. On the other hand, in climates where it takes the entire summer season for a crop of potatoes to mature, the base eyes would form in the hotter weather and the seed end eyes in the cooler fall season.

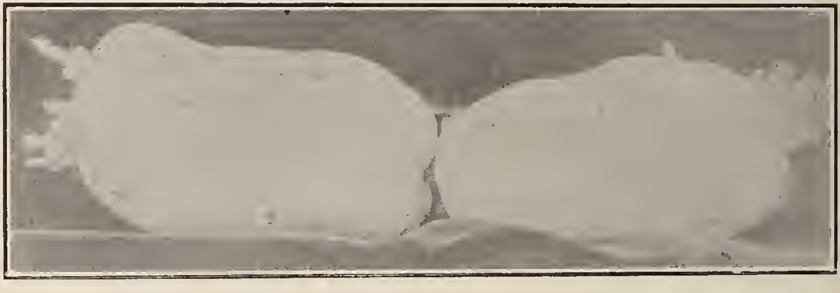


Fig. 6 Maine grown tubers showing strongest sprouts on the seed end.

It is sometimes recommended that the cluster of eyes on the seed end be cut off and not used. This would be bad practice in the case of Maine grown seed.

The difference in opinion found among potato growers with regard to what is the proper sized seed to plant, may be partially ascribed to some of these conditions. Thus, if the potatoes were planted early in the spring and matured in mid-summer, the earliest formed tubers would be the largest and the later formed ones would be small. In this case the large tubers cut would produce the largest crop. On the other hand, if the plants were grown in a cool climate, or were planted late in the summer, then the smaller tubers would have formed under the most favorable conditions and should produce the best crop.

A very important point in saving home grown seed is to look carefully for any tubers that may be attacked with the "small sprouts" disease if such it is. This can be found in a great many varieties especially those that mature in mid-summer such as Early Rose, Early Thoroughbred, Sir Walter Raleigh and Green Mountain. Home grown seed will probably have sprouted some by planting time and by carefully looking them over the affected ones can be easily seen.

Any seed showing the thin thread-like sprouts such as appear on the right hand tuber on figure 1 should not be used.

This condition has not been noticed with Maine grown, or second crop seed.

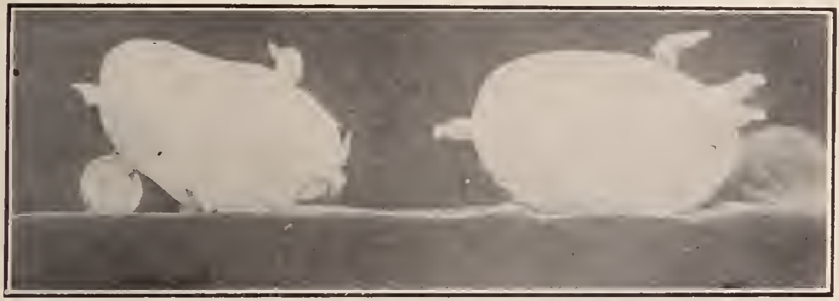


Fig. 7. Home grown tubers showing strongest sprouts at base end.

On the whole where potatoes are to be made a special crop and grown in quantity, it would be most profitable to purchase seed grown in a cool climate. If home grown summer harvested seed must be used, then it will be best to use the large tubers cut to two eyes. These under ordinary storage will have sprouted somewhat by planting time, and any showing weak sprouts should be rejected.

CULTURAL DIRECTIONS

Potatoes for the nearby market as well as for long distance shipping from the eastern shore to Philadelphia and New York, are considered quite a profitable crop in Maryland. These are mainly the early varieties, and the yield ranges all the way from eighty to three hundred and fifty bushels per acre. The farmers in the northern and western counties of the State grow a good many potatoes, but these are generally of later varieties. When an early crop is grown, it is usually planted as soon as the ground can be worked. The late crop is planted in some localities as late as August first.

Soil. A sandy loam well enriched is considered best for this crop. Vegetable matter is needed, but it should be in a thoroughly well rotted condition. Any vegetable matter in a state of decomposition, seems to foster the increase of the potato scab fungus.

Previous treatment of the soil. There is no doubt that the largest yields of potatoes are grown upon soils that have been annually manured for some years previous, and that have not been planted to exhausting crops like field corn.

It is good practice to plan a rotation and manure heavily the crop that precedes potatoes. Cabbage likes a liberal supply of manure, and as fresh manure seems to be suitable for this crop, it could be used freely for the cabbage and would then be well decayed for the potatoes which follow. The potatoes could be succeeded by grass and clover, or wheat with grass, which could be followed by cabbage again, and so on.

If a heavy sod is to be used for early potatoes, it should be plowed in the fall because if spring plowed it cannot be gotten into condition. A thin clover sod might be all right broken in the spring.

Manuring, If as stated above, potatoes follow some crop that has been well manured, commercial fertilizer is all that will be needed to get an early crop. A fertilizer with 7 to 9 per cent of phosphoric acid, 3 to 4 per cent of nitrogen, and 4 to 5 per cent of potash, will give good results.

A good formula for this is the following:

	Pounds
Dissolved Phosphate Rock	1000
Dried Blood	600
Nitrate of Soda	200
Sulphate of Potash	200

If wanted for a late crop the nitrogen need not be as readily available and the following formula may be used:

	Pounds
Dissolved Phosphate Rock	1000
Dried Blood	800
Sulphate of Potash	200

Either of these formulas should be applied broadcast at the rate of fifteen hundred pounds per acre, and be well mixed into the soil with harrow or cultivator.

If it is thought desirable to stimulate the growth of the young plants, one hundred pounds each of nitrate of soda and dissolved phosphate rock per acre, should be scattered in the row when the seed is planted. The potato, having to make its growth in such a short time, needs its food in a readily available condition. The formulas above provide for a generous amount of soluble phosphoric acid which is necessary to make the plant mature in a short time. Early maturity is very important, not only on account of being able to get the crop on the market as soon as possible, but also because some of the early varieties cannot withstand the moisture and heat of early summer, and if the vines are injured by "tip burn," or blight of any kind, the tubers are sure to be undersized.

If it should ever be necessary to use fresh or partly decomposed stable manure for Irish potatoes, then dissolved phosphate rock should be used quite liberally with it. Eight to ten hundred pounds per acre would not be too much if stable manure had been liberally applied. Fresh manure is to be avoided, however, an account of its tendency for increasing the "scab." Lime and wood ashes, while being excellent in general for most soils, should be used with caution for this crop, for the reason that the scab fungus seems to thrive in a neutral or slightly alkaline soil. The acid in the phosphate rock tends to keep the soil slightly acid, a condition favorable to the potato and unfavorable to the scab.

Preparation of the soil. The soil should also be thoroughly prepared mechanically. The plowing should be well and carefully done to the depth of eight inches. As a general thing not enough attention is paid to this matter of plowing. If the subsoil is clay, the drainage can be improved very much by plowing to a uniform depth with a large two horse plow in the direction the land slopes. The bottom of the landside of a large plow makes a runlet for the water. A wheel should be used to secure uniform depth. After plowing, the soil should be thoroughly pulverized by disc harrow or otherwise, to the depth of five inches.

Planting. Plant in furrows three to four inches deep made with a plow. Cover by throwing two furrows on top of the seed. If a planting machine is used, set it to plant the same depth. This method of covering allows for two harrowings which mellow and level the soil before the growth appears.

Seed. The importance of good seed can scarcely be over-estimated. For a good crop of early, uniform tubers, there must be a good start. According to experiments here it is necessary among other things, to start out with a good strong vigorous germ. A vigorous germ or eye can only be secured on some varieties by that germ being formed in a cool climate, or in the fall of the year when the weather is cool. For this reason, growers in the southern part of this state and in the potato growing section further south, should either secure their seed from northern Maine or Michigan, or else replant tubers of the first crop and thus grow their own seed which is called "second crop" seed. The reason that growers in a hot climate felt the necessity of getting their seed from the North, or growing the "second crop," was somewhat obscure until the experiments at this Station during the past three years threw some light upon the matter; see pages 156, 157 and 159.

These experiments showed the need for strong germs or eyes to secure a good crop. Evidently cool weather with a proper amount of moisture is what is needed to produce a strong germ. These conditions may generally be found in the lower sections of Maryland before the first of June or after the last of September. Eyes formed at that time will produce as good as northern grown seed.

Second Crop Seed. The seed called second crop is grown in the following manner: The small unsalable tubers of the June crop should be spread out thinly in a shady place. In two or three weeks they will have turned very green and the larger ones should be cut and the others have a piece taken from the side. It seems that mutilation has a tendency to hasten the development of sprouts. They should then be spread in the sun covering them thinly with earth or sand. After sprouting commences they should be planted in the ordinary way.

If favorable weather conditions prevail, a crop of tubers from the size of an egg to a marble will be harvested late in the fall. These will all make good seed with strong eyes or germs. Another thing in favor of this late harvested seed is that it will not sprout until spring, and thus the first sprouts, which are usually the best, will be saved.

This will be thought by some growers to be too troublesome to practice, but for varieties like Early Rose, or any of the medium maturing varieties, it will be necessary to do this, or get seed from a cooler climate. If seed potatoes are large, they should be cut, for nothing is gained by planting large potatoes. Practically, if there are strong single stemmed plants one foot apart in the row, the largest amount of salable tubers will be produced. Theoretically, pieces of potatoes cut to one eye dropped at that distance would produce these results, but in experience, however, this has not proved to be so, for very often if weather conditions are not just right the small pieces of potatoes decay or dry up before the sprouts have attained sufficient strength to support themselves. To insure a good crop the safest plan is to cut the potatoes so that there will be at least two eyes upon each piece.

It will be found that if the pieces of the seed end and the pieces from the stem end are planted separately a more uniform stand will be insured. The eyes of the seed end sprout quicker than the eyes of the stem end and if they are separated it will be much better for cultivation and harvesting.

This separation of the eyes will not be necessary where second crop seed is being used as these usually start out with one strong germ from the seed end, and about all the cutting needed is to divide the larger tubers in half lengthwise. If home grown seed, aside from second crop is to be used, it should have strong sprouts and be grown in cool weather.

Bud variation is quite common in plant life and potatoes sometimes vary in this way. It will, therefore, pay to go through the patch when the growth is about made or when the plants are in bloom, selecting and marking with a stake those which are most vigorous and healthy. These should be dug and stored separately from the general crop. If it is considered too troublesome to save enough to plant the entire crop this way, enough hills should be marked to produce several bushels. These may be planted separately and all the products be used for seed the following year.

Quantity of seed per acre. This will vary according to the size of the tubers. If large potatoes with few eyes are used, twelve to fifteen bushels are necessary, and if medium to small potatoes with plenty of eyes are planted, only eight to twelve bushels will be needed.

Cultivation. If the seed is covered with a plow the land will be left in a ridged condition. A week or two after planting, these ridges should be leveled down with a board or clod crusher. Just as the plants appear a smoothing harrow should be used to level the ground and kill the weeds. Very often, especially in late crops, it is not necessary to do any hand hoeing if this harrowing is thorough. Cultivation can be done with an ordinary five shoveled Iron Age or similar cultivator. Small shovels can be used the first time, stirring the soil deeply. At the last cultivation a broad shovel behind will work about the right amount of earth up to the hills.

Harvesting. As a general rule potatoes should not be dug until the vines mature and die, as the tubers will increase rapidly in size after the vines begin to turn yellow. After the vines are dead there is nothing gained by leaving the crop in the ground.

It is best not to dig if the sun is bright and the weather extremely hot for the tubers are easily scalded. The digging should be done in cloudy cool weather if possible.

There are several potato diggers on the market and where everything is in proper condition, with no rocks, weeds, or anything that will hang or clog, good work can be done with them. Many small growers, however, depend upon the plow and potato hook. A large one-horse, or small two-horse, plow set at just the right depth to run beneath the potatoes without cutting them, will turn the hills bottom side up so the tubers may be easily removed with potato hooks.

The grading may as well be done in the field even though the crop is not to be sold at once. The grades should be firsts, seconds and culls. Only the firsts should be shipped to distant markets, the seconds had better be disposed of near home. The culls can sometimes be sold to bakers who use them in connection with yeast in bread making.

When shipping to early markets, barrels or boxes must be used, as there is much less danger of bruising and heating than if placed in sacks. For the late crop, sacks are often used and are quite economical. One and one-half bushels are usually put into each sack.

Storing. Potatoes should be placed in the dark as soon as possible after digging. Light will turn the skins green and bitterness will extend into the flesh, making them very unpalatable. A temperature at or a few degrees below 40° F., will keep potatoes in good condition. Cellars under barns or dwellings or specially constructed vaults or caves, are often used. The storage place should be easy to ventilate, but need not be extremely dry. Storage in kilns or pits is often practiced, and where there is no frostproof building it is very cheap and convenient.

For a pit or kiln a high and well drained spot should be selected. Scrape away an inch or two of soil and cover with a layer of dry straw. The potatoes should be piled upon this, not more than ten bushels in the pile, and be covered with straw and one foot to fourteen inches of earth. Only sound potatoes should be stored in this way. If there is the least sign of rot the crop should either be sold at once or stored in boxes where they can be picked over occasionally.

Varieties. The selection of varieties must be governed by the market demands. Three very popular varieties at present are, for extra early, Early Ohio; for medium early, Irish Cobbler; and for main crop, Green Mountain. These are all of good quality and sell well. For yields of other varieties see pp. 164 and 165.

DISEASES

Early blight. Brown spots with faint rings in them appear on the leaves. These gradually cover the leaf, killing it. Spray with Bordeaux mixture three times between June 15 and digging time in the fall. The McCormick potato is not much troubled with this disease.

Late blight. In moist summer weather, late blight appears suddenly as soft, bad smelling, dark areas in the leaves and may kill whole fields in a short time. It is not common in this state. The treatment for this disease is the same as for early blight. The affected tubers may rot.

Brown rot. The leaves and stem wilt and shrivel and the tubers later show a wet rot. Thorough spraying with Bordeaux mixture and arsenicals is necessary to keep down insects which carry the germs. Do not plant on land which has recently borne potatoes, tomatoes or egg plant, all of which are subject to the disease. Store potatoes in cool, dark places.

Dry rot. This disease causes lighter colored and more or less rolled up leaves. The tubers later may be destroyed, at least at one end. by dry rot. Avoid infected soil and do not plant tubers that have internal brown or black streaks.

Scab. Scabby spots develop on the tubers. Soak uncut seed tubers in formalin, one-half pint to fifteen gallons of water, for two hours, and plant on scab free land. Avoid the use of alkaline fertilizers.

THE MARYLAND
Agricultural Experiment Station

Bulletin No. 133 May, 1909

CABBAGE EXPERIMENTS AND CULTURE

By C. P. Close and T. H. White

INTRODUCTION

The cabbage crop in Maryland is a very important one. Large quantities are grown for the markets of Baltimore and Washington and for the smaller markets throughout the State. It is used for immediate consumption and for making into sauerkraut.

This Experiment Station has been testing varieties for the past ten years. Wet and dry seasons have been experienced and these have given good opportunities for noting the behavior of the different varieties under these conditions. Experiments have also been made with fertilizers and soils, and some notes as to the resistance of types and varieties to disease, have been made. Seeds of French varieties were imported and tested along with the American kinds.

EXPERIMENTS

An outline of the several experiments may be briefly stated as follows:

Experiment No. 1. To note the effect of soil treatment, that is, with stable manure and chemical fertilizers, and their relation to cabbage diseases.

Experiment No. 2. The value of a high priced fertilizer compared with a lower priced, poorer grade.

Experiment No. 3. The effect of excessive amounts of the various fertilizing elements applied to the seed bed.

Experiment No. 4. The resistance of varieties to disease.

No. 1. EFFECT OF SOIL TREATMENT ON CABBAGE DISEASES.

The susceptibility to rot and disease of cabbage growing on very rich, highly cultivated land, seemed to be due more to something unsuitable in the soil rather than to the direct attacks of bacteria or fungi. During very rainy weather in the heat of summer, young and apparently vigorous cabbage plants will wilt and die. If the weather is moderately dry and the soil loose and well cultivated, cabbage will grow vigorously and seemingly resist disease even if the soil is known to be infected with germs. It was noticed that a patch of cabbage planted on a piece of land that had been used to grow celery for several years, grew very well until heavy rains began to fall in August. In the bright sunshine which followed, the plants wilted and many afterwards died.

The crop was a failure except a portion of the lower corner which was on a poor clay knob and there a few good heads matured.

Due consideration was given to the fact of poor drainage and also to excessive amounts of water about the roots to which might be attributed much of the failure. Still it seemed a plausible conjecture that there might be extraordinary amounts of soluble salts in the soil and that they would have a poisonous effect on the cabbage roots.

The first experiment bearing upon this point was made in the summer of 1905. A piece of rather stiff clay land, one-eighth of an acre in size, that had been manured and planted to truck crops for many years and upon which cabbage had rotted badly the preceding year, was again treated with ten tons per acre of rotted manure. This was plowed down and the land was prepared for the crop.

Plots were marked off and treated as follows:

Plot 1. Complete fertilizer, 1000 pounds per acre,
Plot 2. Check, no fertilizer.
Plot 3. Lime, 60 bushels per acre.
Plot 4. Sulphate of potash, 300 pounds per acre.
Plot 5. Muriate of potash, 300 pounds per acre.

It had been noticed in some other work under similar conditions that muriate of potash seemed to have the effect of promoting the vigor of the plants. Fifteen varieties of cabbage were planted across the plots, nine varieties of French and six of American origin. The plants were set June 23. They started off nicely and grew well until the first week of August, at which time there were incessant rains followed by bright sunshine.

All the plants on all the plots wilted down and only a few recovered. Most of those wilted died in a short time with black rot. A few lingered on, but did not make any satisfactory heads. The results from either of these treatments seemed to be negative. The same season other small plots under the same conditions were treated with potash as follows:

Plot 1. Muriate of potash, 300 pounds per acre.
Plot 2. Muriate of potash, 600 pounds per acre.
Plot 3. Muriate of potash, 900 pounds per acre.
Plot 4. Check, no fertilizer.
Plot 5. Sulphate of potash, 300 pounds per acre.
Plot 6. Sulphate of potash, 600 pounds per acre.
Plot 7. Sulphate of potash, 900 pounds per acre.
Plot 8. Lime, 60 bushels per acre.
Plot 9. Common salt, 200 pounds per acre.

Twelve plants of Premium Flat Dutch cabbage, that had been grown in beds treated with the same kind and amounts of fertilizers used on the plots, were set on each of these plots, June 23. They started off and grew well until the excessive rains came on. As a result, most of the plants wilted badly except those on the plots receiving muriate of potash. The excessive rainfall continuing, many of the plants on all the plots became affected with rot and died. At the time of maturity in the fall the results were:

Plot 1. 6 alive, 4 good heads.
Plot 2. 3 alive, 3 good heads.
Plot 4. 3 alive, 0 good heads.
Plot 5. 4 alive, 0 good heads.
Plot 6. 9 alive, 0 good heads.
Plot 7. 7 alive, 1 good head.
Plot 8. 7 alive, 2 good heads.
Plot 9. 6 alive, 0 good heads.

Under these conditions none of the treatments seemed to be of much benefit. Even lime, which is considered by many to be a "cure all," failed to give any positive results. In order to further investigate this matter, the same piece of land was manured and plowed and let lay rough all winter. In the spring, rows were laid off with a plow across the plots of the previous year and manure and fertilizer were applied in the rows as follows:

Row 1. 10 tons of fresh manure per acre.
Row 2. 1000 pounds dissolved phosphate rock per acre.
Row 3. 600 pounds muriate of potash per acre.
Row 4. 1000 pounds dried blood per acre.
Row 5. 500 pounds dissolved phosphate rock, 300 pounds muriate of potash, 500 pounds of dried blood per acre.
Row 6. 300 pounds common salt per acre.
Row 7. Check, nothing applied.

Wishing to note the effect of throwing up ridges and planting on them. thus giving a better opportunity for drainage, half of the patch was ridged. The other half was leveled and the plants were set. Henderson's Succession was used and the cultivation was done so as to maintain the ridges and level ground throughout the season as planned.

The season again proved very wet and in August the plants began to die. On account of the spongy condition of the soil the ridges were continually saturated, but no water stood around the plants, as it did in pools on the level culture during heavy downpours. Under these conditions the plants became affected and died off until all were dead on the level culture portion. Out of the 35 plants set on each ridge row not one produced a good head, but the following numbers were alive in late September.

Row 1.	8 plants	Row 5.	5 plants.
Row 2.	8 plants.	Row 6.	4 plants.
Row 3.	0 plants.	Row 7.	8 plants.
Row 4.	6 plants.		

These experiments failed to show that any benefit could be derived from using these various materials and cultures as correctives of the supposed excessive salts or poisonous matter in the soil. Meanwhile good cabbages were being grown on other parts of the farm on the same character of soil and drainage, with the exception that the land had been in sod from which hay had been cut.

Thinking that probably grass when cut from hay corrects conditions otherwise unfavorable for cabbage, and since it was impossible to produce sod on the plot in a short time, wheat was sown on one-half of the plot in the fall of 1906 in the hope that it would have an influence similar to the supposed influence of grass. The wheat, though planted late, grew well and its heavy growth of straw and dark green color gave evidence of the fertile condition of the soil. The other half of the plot upon which nothing was sown was disced in the spring to keep down the weeds.

The wheat was taken off July 6 and the whole plot was immediately plowed, rolled, and harrowed. On July 12 the plants were set and nine varieties were used in the work.

The season was favorable and during the critical period of August and early September it was comparatively dry. For the first time in four years some good heads of cabbage were grown on this plot. A good many plants of some varieties died as usual, but on the whole there was much improvement. The half of the plot producing wheat contained 308 good heads at harvesting time and the other half contained 363 good heads from the 540 plants set on each half. This would indicate that a crop of wheat did not have the effect of sod on the cabbage crop, for the wheat growing half of the plot produced 55 heads less than the other half.

Surplus available nitrogen. A secondary experiment was carried on at the same time to determine if a surplus of available nitrogen would tend to make the plants less disease resistant, or otherwise affect the crop. The plot was divided into halves across the wheat stubble and the other part. One-half received a mixture of fertilizers rated per acre as follows;

	Pounds
Dissolved phosphate rock	800
Kainit	320
Tankage	320
Nitrate of soda	320

There seemed to be no difference between that portion of the plot from which the crop of wheat had been taken and the other part.

The plot receiving nitrate of soda produced 322 good heads and the other plot produced 349 good heads. This is a difference of only 27 heads and may be an indication of the presence of too much soluble nitrogen in the soil.

The comparative disease resistance of the nine varieties grown is discussed under "Resistance of Varieties to Disease."

As nothing definite had been accomplished to improve soil conditions by any of the treatments mentioned above, this feature of the work was left out in 1908, and without further manuring or fertilizing late cabbage was planted on this plot. Seventeen varieties were included for a test of varieties and disease resistance.

The season was again quite dry at the critical time in August and some varieties lost but few plants while other varieties lost nearly all. Out of 612 plants set, only 380 reached maturity, the others being killed by disease.

THE RESISTANCE OF VARIETIES TO DISEASE

While doing the variety testing, attention was called to a variety said to be free from rot which was being grown by the truckers near the Experiment Station. This proved to be Landreth Market Gardeners Large Late Flat Dutch. There were also some other varieties that were disease proof to a remarkable degree. It was noticeable also that this disease resistant stock all conformed to one type, of vigorous growth, with green or purplish green curled and crinkled leaves. It seemed to be very hardy, as it stood in the field throughout the winter and produced seed in the spring.

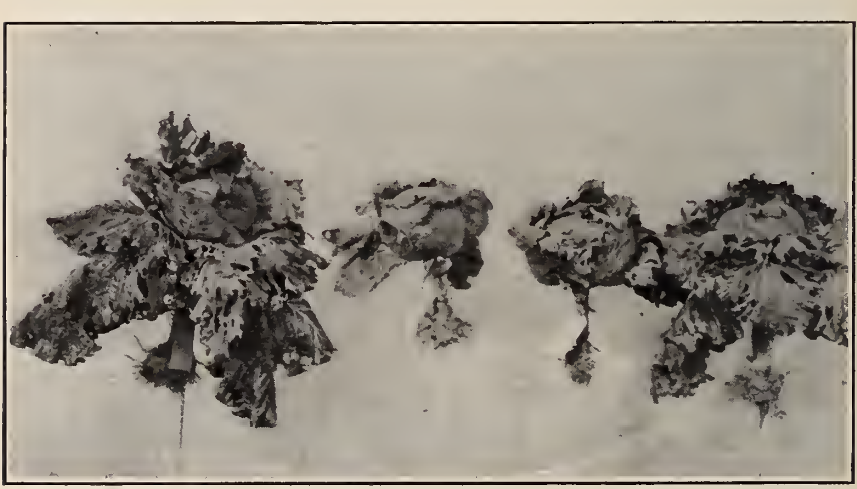


Fig. 1 Showing two types of Flat Dutch Cabbage. The two outside heads are the purplish green resistant type, and the two inside are the whitish green less resistant type. Note the amount of outside leaves retained by the resistant plants.

It was also noticed that cabbages of the Savoy type were very disease resistant and usually stood conditions that would destroy cabbage of the ordinary Flat Dutch type.

The ordinary Flat Dutch type of cabbage has plain leaves, whitish green in color. Some varieties grow very large and for late use have been very popular on the markets. There seems to be much mixing of types in the different varieties sent out by the various seedsmen. Two seedsmen may send out seed under the same name and yet the cabbage will be of different types. For instance, Landreth Autumn Giant has the dark purplish green curled leaf of his Flat Dutch, while Henderson Autumn Giant is of the ordinary Flat Dutch type of plain whitish green leaf. Market gardeners who wish to grow cabbage and have only very rich, well cultivated land where rot is liable to be troublesome, should plant cabbage of the purplish green and Savoy types for their late crops.

For early planting no special selection is needed, as most early cabbages are mature and marketed before the unfavorable weather conditions begin. For the benefit of those who wish to know the different types as far as they have been tested here, the varieties have been arranged under three headings as follows:

Type 1. These are large, vigorous growing, purplish green, curled and crinkled leaf cabbages. They are most resistant to diseases. Some varieties are Landreth Market Gardeners Large Late Flat Dutch, Landreth Surehead, Landreth Autumn King, Burpee Autumn King, Burpee Surehead, Illinois Winter Market and Houser.

Type 2. The Savoy type has curled, crinkled, and netted green leaves. They are fairly disease resistant. Some varieties of this type are Perfection Savoy, Ironhead Savoy and Brunswick Netted Savoy.

Type 3. These are plain, whitish green leaved varieties, easily affected by disease. Some of these are Henderson Matchless Large Late Flat Dutch, Henderson Selected Large Late Flat Dutch, Marblehead Mammoth, Maule Prize Flat Dutch, Succession, Wood & Sons Autumn King, Henderson Autumn King and Bolgiano Premium Flat Dutch.

As a sub-type of similar character and even less resistant may be mentioned the round headed varieties such as Danish Ball Head, Summer Danish Ball Head, and Hollander or Danish Ball Head.

HIGH PRICED AND LOW PRICED FERTILIZER

In experimental work with fertilizers it was noticed that a mixture relatively low in nitrogen and potash and therefore low in price would sometimes give as good results as a higher priced article. This is also often the experience of farmers.

It is a well known fact, in practice, that kainit applied to crops often increases the yield far in excess of what could be attributed to the small amount of potash it contains.

The first experiment bearing on this subject was tried on late cabbage in the season of 1907.

The soil used was a clay loam located on a piece of level bottom land. It was in mixed grass sod and a crop of hay had been taken off annually for the past five years. It was quite fertile and would probably produce sixty bushels of corn or twenty-five bushels of wheat per acre.

The land was plowed early in the season and was occasionally harrowed until within a week of planting time, when the fertilizer was sown broadcast and harrowed in.

The fertilizer formulas were as follows.

Plot 1. High priced goods, amounts per acre.

	Pounds	*Analysis*		*Cost*
Dissolved phosphate rock	240	Phosphoric acid	4 to 5	$16.70
Nitrate of soda	120	Nitrogen	8 to 9	
Dried blood	400	Potash	6 to 7	
Muriate of potash	100			

Plot 2. Low priced goods, amounts per acre.

	Pounds	*Analysis*		*Cost*
Dissolved phosphate rock	400	Phosphoric acid	7 to 8	$ 7.70
Tankage 7 per cent	300	Nitrogen	2 to 3	
Kainit	120	Potash	1 to 2	

The cabbage was all of the same variety and planted on the same day. Cultivation was similar all through. A good crop was harvested. The yields were as follows:

Plot 1		*Plot 2*	
Pounds	31460	Pounds	31944
Value	$157.30	Value	$159.72

The yields were practically the same, being slightly in favor of the low priced fertilizer.

The next experiment bearing on this matter was tried in the season of 1908. The piece of land, a light clay loam, had been in timothy grass which had given way to wild grasses. Hay had been taken from the plot the year before, and the stubble was turned down in the early spring. The land was thoroughly prepared, the fertilizers sown, and the cabbage planted July 22.

In this case plot No. 1 was a check plot with nothing applied. Plot 2 was given the same high priced fertilizers as plot No. 1, in 1907. Plot 3 was given the same low priced fertilizers as plot No. 2 in 1907.

The season was very dry and the crop suffered from lack of water.

The yields of the three plots were, per acre, as follows:

	Plot 1	*Plot 2*	*Plot 3*
Cabbage pounds.........	13972	27020	18792
Value..................	$69.86	$135.10	$93.96

These results are just the reverse of the 1907 results, the high priced fertilizer giving an increase of $41 per acre over the low priced fertilizer.

Another piece of land that had been in field corn in 1906 was planted to apple trees in the spring of 1907. During that year various kinds of vegetables were planted between the trees, and no manure or fertilizer was used. The soil was a stiff clay loam. It was plowed early and the same low priced fertilizer that was put on plot 2 in 1907, was sown broadcast and harrowed in. The season was very dry, but the plants grew well without a check.

On part of this land several varieties of cabbage were planted and all of them made good heads. There were some signs of disease early in the season, but after the weather became dry this did not increase, and even the susceptible varieties like Danish Ball Head, made excellent heads.

The yield on this plot was at the rate of 35,332 pounds per acre valued at $176.61. This was a better yield than the sod land gave with the high priced fertilizer. It is most probable that had the season been wet, the sod land would have given best results and also that the low priced fertilizer may have been just as good. Thus it may be fair to conclude that from no especial brand of fertilizer can the same results be expected under all conditions of soil and seasons.

EXCESSIVE AMOUNTS OF PLANT FOOD USED ON SEED BEDS

It is the practice of growers of late cabbage in this section, to select a piece of poor light soil upon which to make their seed beds. This is given a very liberal dressing of commercial fertilizers. The plants produced are usually very wiry or woody, and tough, and withstand well the check incident to transplanting. The growers prefer a plant of this character to one that is succulent and green.

The idea of this experiment was to notice the effect of the different fertilizers on the plants and also on the matured crop. It is the practice of some florists when wishing to produce extra fine heads of the cockscomb, to first stunt the plants in poor sandy soil, and then afterward plant them in very rich soil. In this way they secure very fine blooms.

Knowing that some fertilizers have a hardening effect so that woody tissue is producd, it was thought that experiments might indicate the proper materials to use.

For the first experiment, season of 1907, plots were laid off on fairly good soil and treated with the following amounts of fertilizer per acre.

		Pounds.
Plot No. 1	Nitrate of soda	450
Plot No. 2	Dissolved phosphate rock	450
	Dried blood	450
	Nitrate of soda	450
	Muriate of potash	300
Plot No. 3	Dissolved phosphate rock	900
Plot No. 4	Dried Blood	900

The fertilizers were raked in and the seed sown. The seed came up well and at planting time the plants on plot No. 1 were very dark green and dwarf. Those on plot No. 2 were good plants of a darker shade of green than normal. Those on plot No. 3 were not as dark green, but nearly as large as the others. Those on plot No. 4 were quite succulent and dark green in appearance. The season for planting was good and there was no appreciable difference with regard to the stand. All of the plants grew. At harvest time the only difference that could be seen was in the plants which had been treated in the seed bed with nitrate of soda; these, while not any larger than the others, had all headed well.

The same experiment with slight changes was made in the season of 1908. This time the plots received fertilizers per acre as follows:

		Pounds.
Plot No. 1.	Dissolved phosphate rock	900
	Muriate of potash	300
	Dried blood	750
Plot No. 2.	Dissolved phosphate rock	900
	Muriate of potash	300
Plot No. 3.	Dissolved phosphate rock	900
Plot No. 4.	Nitrate of soda	600

The work was done the same as last year. The plants on plot No. 1 were strong, vigorous plants. Those on plot No. 2 and No. 3 were paler green in color. Those on plot No. 4 were very dark green, the same as in 1907.

The plants were set on a part on the same piece of sod land upon which the high and low priced fertilizer experiment was tried. The yield in pounds per acre and the value are as follows:

	Pounds.	*Value.*
Plot No. 1	19360	$96.80
Plot No. 2	19844	99.44
Plot No. 3	17364	86.82
Plot No. 4	23252	116.25

The results were in favor of the plants from seed beds receiving nitrate of soda, and as this was also true the year before, it seems as though it would pay to use nitrate of soda on the plant beds.

TESTING OF VARIETIES

The work with varieties commenced in 1903. The names and average weight in pounds and ounces per head are as follows:

Season 1903.

Variety	*lbs.*	*ozs.*	*Remarks*
Maule Midsummer	2	6	The best general appearance was made by Thorburns Large Late Drumhead, with Succession next. The Houser and Illinois Winter Market stood the best and gave the largest gross yield. These varieties have purplish green leaves somewhat crinkled and curled. Autumn King is similar in type, but made larger heads. Lupton, Danish Roundhead and Marblehead Mammoth suffered so severely from black rot as to be almost a failure.
Thorburn Large Late Drumhead	6	2	
Houser	3	2	
Lupton	1	12	
Marblehead Mammoth	1	13	
Danish Round Head	1	1	
Succession	3	2	
Livingston Ideal Winter	4	3	
Illinois Winter Market	3	1	
Stonemason Drum-Head	3	0	
Thorburn Autumn King	6	0	
Thorburn colossal	4	5	
Surehead	3	12	

Season 1904.

	Remarks
Autumn King	Many of these although headed, had rotten leaves, but compared favorably with other varieties.
Dreer Select Flat Dutch	Poor, made very little growth.
Salzer Hundred Weight	No better than Dreer Select Flat Dutch.
Salzer Kraut King	A little better than Salzer Hundred Weight
Short Stem Drumhead	Not quite as good as Salzer Kraut King.
Livingston Drumhead	About like Short Stem Drumhead.
Salzer Giant Flat Dutch	Fair growth, some disease.
Illinois Winter Market	Very good, purplish green crinkled leaves. No Disease.
Large Late Drumhead	Very poor.
Burpee Surehead	A good growth, similar to Illinois Winter Market. No disease or rot.
Bloomsdale Large Late Flat Dutch	A good growth. Disease resistant type like Surehead and Illinois Winter Market.
Burpee Safe Crop	Very fair. Apparently the best of the smooth leaved, whitish green sorts.

Variety	*Remarks*
Acme Flat Dutch	Very poor and much rotted.
The Lupton	Very poor and much diseased.
Danish Roundhead	Not Good.
Succession	Very poor.
Premium Flat Dutch	Very poor.

The season of 1904 was wet. The above varieties were planted on the rich spongy piece of land used for Experiment No. 1.

Season 1905. The varieties of cabbage were planted on same piece of land used in 1904. The season was wet.

Variety	*Remarks*
Landreth Market Gardener Large Late Flat Dutch	Doing very well, some good heads.
Illinois Winter Market	Good growth.
Autumn King	Very good.
Houser	Doing very well.
Succession	Suffered badly with disease.
Volga	All died.
French Varieties	
Milan d'St. Jean	Savoy type, all dead.
Milan d'Aubervilliers	Savoy type, many died, some fair heads.
Milan Gros d'Vertres	Savoy type, all dead.
Milan d'Pontoise	Savoy type, many dead. No good heads.
Milan d' Nouvege	Savoy Type, some dead. No good heads.
Chou d'Schweinfur	Whitish green type. No good heads,
Chou d'St. Dennis	Whitish green type, all dead.
Chou d'Vaugirard	Whitish green type, all dead,
Chou Quintal d'Auvergne	Whitish green type, many dead, no good heads.

Season 1907. The varieties were planted on a piece of sod land plowed early in the spring.

Variety	*Remarks*
Landreth Market Gardener Large Late Flat Dutch	Very vigorous healthy growth.
Burpee Surehead	Is similar to Landreth Large Late Flat Dutch.
Landreth Autumn King	Is similar to Landreth Flat Dutch.
Bolgiano Extra Large Late Flat Dutch	Whitish green type. Plants have lost nearly all lower leaves. Some good heads. See figure 1.
Wood Prize Head Flat Dutch	Better than Bolgiano, but not as good as Landreth Flat Dutch.

Variety	*Remarks*
Bumcombe North Carolina Winter	Very similar to Wood Flat Dutch.
Harris Perfection Late Winter	Very similar to Wood Flat Dutch.
Landreth Frost Proof Large Drumhead	Very similar in type to Landreth Flat Dutch, but heads are not quite as large.
Danish Round Head	Small round heads, not vigorous.
Bronxa	Similar to Danish Round Head.
Bolgo	Whitish green Flat Dutch type, not vigorous.
Gabourowka	Whitish green Flat Dutch type.
Danish Succession	Very much like Henderson Succession.
Geogia Collards	Vigorous growth with large green leaves, do not form heads.
Green Glazed	Good growth, not much affected by worms but made no good heads.

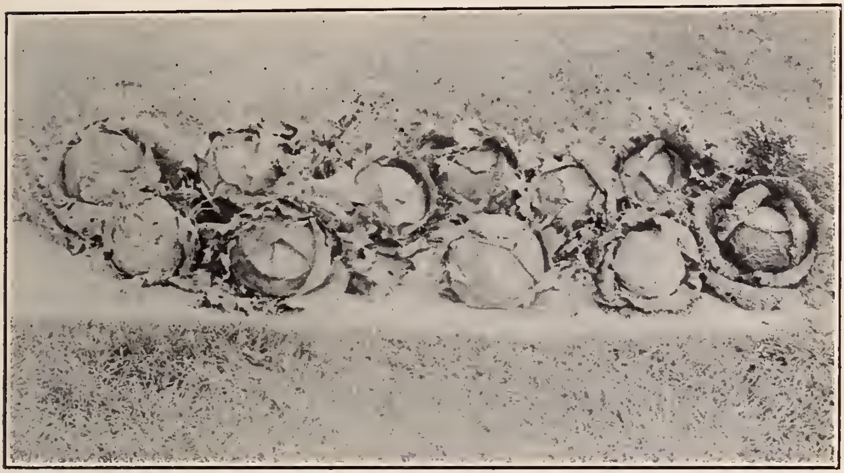


Fig. 2 Varieties of cabbage. 1—Perfection Savoy. 2—Drumhead Savoy. 3—Landreth Market Gardener Large Late Flat Dutch. 4—North Carolina Buncombe. 5—Bolgiano Large Late Flat Dutch. 6—Haines Perfection Late Beauty. 7—Landreth Frost-Proof Drumhead. 8—White Wonder. 9—Burpee Surehead. 10—Wood's Prize Head Flat Dutch. 11—Autumn King.

In order to get some notes on the resistance of the above varieties to frost, they were left in the field until December 16. There had been several severe frosts before that date. All the varieties with the exception of the Georgia Collard, Landreth Market Gardeners Large Late Flat Dutch, and Autumn Giant, suffered severely.

Some of the Landreth Market Gardeners Large Late Flat Dutch were left in the field during the winter and were sufficiently hardy to resist the frost and retained enough vitality to shoot to seed in the spring.

Season of 1908. The varieties of cabbage were planted on three different pieces of land. The first was a piece of sod land. The second was land that had been under cultivation in field crops for several years, and the third was the same piece that had been used in the investigations of diseases for several years past. The plants on the first piece all grew well and made good heads, but suffered severely from drouth. There was no black rot of any account among them. The second piece of land produced the best crop and all varieties made good heads. In fact it was the best crop of cabbage of all varieties that had been grown at the experiment station for ten years. A little of the black rot disease started, but disappeared as soon as the weather got dry.

On the third piece of land the cabbage did not do as well, although better this season than ever before. The weaker varieties like Danish Ball Head and others of the whitish green type, were considerably diseased.

The following varieties were tested in 1908. The average weight per head is given.

	WEIGHT		
Variety	*lbs.*	*ozs.*	*Remarks*
Danish Ball Head	3	0	Round hard heads.
Summer Danish Ball	3	8	Flattish heads, deep green, quite solid.
Hollander, or Danish Ball Head	3	12	Round hard heads.
Brunswick Netted Savoy	3	8	Savoy type, strong grower
Brill Long Island second Early	7	0	Good, solid, medium size heads
Red Dutch	4	0	Purple, hard heads.
Landreth 100 day	5	4	Good, medium size.
Brill Nonsuch	7	12	Medium size, good solid heads.
Volga or Russian	6	0	Good heads, half pointed type.
Johnson Ever-Ready	5	8	Similar to Volga.
Burpee Short Stem Drumhead	4	8	Flat Dutch type, medium vigorous.
Marblehead Mammoth	7	4	Large Flat Dutch, whitish green type.
Bolgiano Premium Flat Dutch	7	0	Whitish green Flat Dutch type.
Landreth Market Gardeners Large Late Flat Dutch	5	8	Purplish green crinkled leaves, vigorous.
Wood Autumn King	7	8	Similar to Marblehead Mammoth.

Variety	*lbs.*	*ozs.*	*Remarks*
Landreth Autumn King	5	8	Similar to Market Gardeners Large Late Flat Dutch.
Henderson Autumn King	5	0	Vigorous, whitish green.
Burpee Autumn King	5	0	Similar to Landreth Autumn King.
Landreth Surehead	5	0	Similar to Burpee Autumn King
Burpee Surehead	6	0	Much lighter green than Landreths Surehead.
Henderson Matchless Large Late Flat Dutch	8	4	Similar to Marblehead Mammoth.
Maule Prize Flat Dutch	9	0	Whitish green, medium vigorous.
Henderson Selected Large Late Flat Dutch	6	0	Not as vigorous as Henderson Matchless.
Henderson Succession	5	0	Uniform heading, medium size.

There appears to be great variability in the varieties of cabbage as purchased from the different seedsmen. For instance, Landreth Autumn King and Burpee Autumn King are of the purplish green type that are hardy and resistant, while Henderson Autumn King belongs to the whitish green type which contract black rot and other diseases very readily when the conditions favor their development. Wood & Sons Autumn King seems to be quite different, being much larger and similar to Marblehead Mammoth. Most of the varieties received from Landreth seem to have the purplish green crinkled leaves. It is probably this that makes them distinctive as the "Landreth" cabbage.

It is interesting to note that the varieties which are resistant to cold are also resistant to heat, moisture and disease germs. In the lower sections of Maryland where the seasons are liable to be wet and the nights hot, it will be well to plant for the late crop, varieties having the purplish green, crinkled and curled leaves.

CONCLUSIONS

Cabbage is subject to, and often dies from, stem rot, black rot, root rot and other diseases. The spores of these diseases are generally present in sufficient quantities to inoculate the crop and only need favorable conditions for development. If, then, something could be done so as to do away with any conditions favoring the development of these diseases, farmers could work with more assurance of a crop. That the conditions of soil and weather are important factors is evident from the foregoing work.

With a soil of the character described above, rich, spongy and full of humus, a crop could not be grown in a rainy season. It might be supposed that if such a soil were thoroughly drained it would insure a successful crop. This is doubtful, however, as such soils hold water like a sponge and water drains very slowly from a sponge, even if there is good opportunity for it to pass off below. This amount of water, however, is likely to dissolve and to hold in solution, enough soil salts to poison the roots of 'the plants. The roots being partly decayed cannot absorb sufficient water to supply the needs of the plants at this, the most trying season, of their growth. This causes a check in the growth, making favorable conditions for disease germs to enter.

During the three seasons in which cabbage could not be raised on the experiment plot, good crops were being grown on soil quite similar when considering the amount of sand, clay and silt in each. They were totally different, however, in their capacity to retain water.

To be able to grow cabbage successfully in this climate, in any season, the soil should be in such a condition that the water will pass through it as freely as it would through a piece of pumice stone or porous rock. As a general rule the poorer the soil the drier and more porous it is. Thus it is that on the comparatively poor farms better late cabbages are grown than in the market gardens that are very rich.

A sod field broken early in the spring and well manured has generally been found to grow the best cabbage. This does not apply to the early crops; these do best on the soils that are rich and full of humus.

Low priced fertilizers sometimes give as good results as the higher priced goods, but on the whole it will pay to be liberal with nitrogen. The two experiments indicate that it is profitable to use nitrate of soda on the plant beds, at the rate of 450 to 600 pounds per acre.

In localities and on soils where cabbage diseases are prevalent, it is safer to plant the type of cabbage with the purplish green crinkled leaves. Late cabbage does well on ordinary farm land.

The crop generally seems to do better if the field is marked off both ways and the plants are set in the check and the cultivation is level.

CULTURAL DIRECTIONS

Origin. The cabbage is a native of western and southern Europe and has been used for human food from time immemorial. All of the types of cabbage, cauliflower, Brussels sprouts, collard, and kale have sprung from the same original source, namely, *Brassica oleracea*, Linn. The wild type is still growing on the chalk cliffs of the English Channel.

On the cliffs of southeastern England is now found a plant similar to the Georgia collards.

Types. There are three distinct types of cabbage with reference to the shape of the head, namely, round, oval and flat. Some varieties are distinct in type while others partake of two or more shapes due to crossing in seed production. There is much variation in the shape, color, character and texture of the leaf, ranging from regular straight edges, almost white, smooth and tender, to irregular almost fringed edges, dark purple color and coarse, tough texture.

Generally speaking all varieties are hardy, but there is some variation in hardiness. Usually the purplish-green varieties with crinkled and fringed leaves are hardier than the whitish-green sorts with smooth, regular leaves. The cold resisting varieties are also the most heat resisting.

Propagation. For a very early crop the seed may be sown in a well prepared seed bed outside in September and the plants be wintered over in a cold frame or by mulching with straw in a sheltered place. These plants may be set out very early in spring, long before spring grown plants may be used.

For early crops from spring grown plants, the seed is sown in the hot beds or greenhouse in February or March, that is, about four or six weeks before the plants may be set out of doors. To make extra good plants they will need to be taken from the seed bed and be pricked out two inches apart in other beds.

For late crops the seed is sown in beds outside the latter part of May. When pulled the roots should be dipped in thin mud to keep them moist until they are planted.

By setting a succession of plants the crop may be constant from May or June until Christmas.

Field culture. The plants of early varieties are set out in spring as early as the weather permits, in rows three feet apart and two feet apart in the rows. The fall grown plants are often planted in the field in November. Furrows are turned where the rows are to be and the plants are set low in the furrows so as to be protected. North and south furrows with plants set on the east side are satisfactory, although east and west furrows are sometimes preferred. The plants are set one foot apart because some are likely to run up to seed and become worthless. These should be destroyed.

Later varieties require more room. Early plants must be set deep, that is, so the base of the leaves is below the ground. If freezing weather comes the plants may be covered with earth until danger from frost is over.

Sometimes the seed is sown where the plants are to grow. Mark out the rows both ways and plant seven or eight seeds in each hill. When three or four inches high take out all but one plant.

Cultivation must be done thoroughly and often, for the cabbage is a gross feeder and needs plenty of moisture. A cultivator with fine teeth is most desirable.

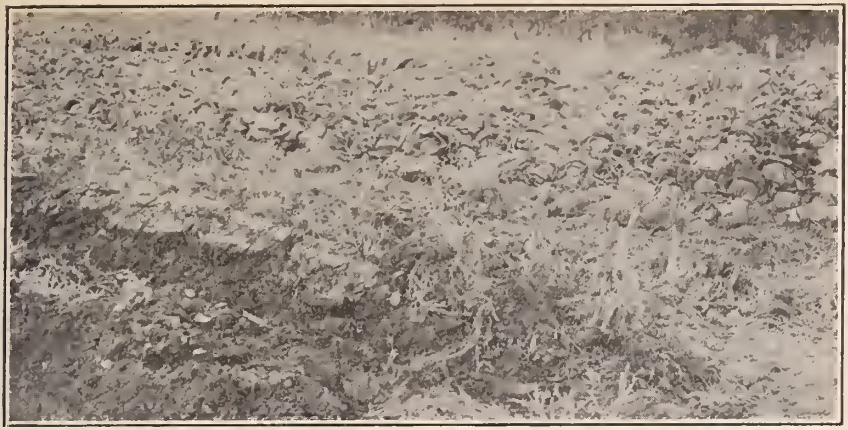
Soil. The early varieties do best on a good sandy loam which has been well manured for several years. The lighter soils are also very good. Late cabbage does best on heavier loams.

Manures and Fertilizers. Well rotted manure is most suitable for early cabbage where a rapid growth is necessary. This may be supplemented by quick acting chemical fertilizers like nitrate of soda and dissolved rock, about 200 pounds of each per acre. The midseason crop does not want so much fertility, for the growth should not be pushed so fast. Late cabbage needs different treatment. It does best on sod land which has been given eight or ten tons of stable manure and is plowed very early in spring. Corn ground, with crimson clover for a cover crop, manured and plowed early in spring, is also good. If manure is not available the following amounts of fertilizer per acre may be broadcasted a short time before the plants are set: 240 pounds of dissolved rock, 400 pounds dried blood, 120 of nitrate of soda and 100 of muriate of potash. The fertilizer should be worked into the soil with a good harrow.

Harvesting. Early cabbage is cut and sold as soon as the heads are large enough. The loose leaves are taken from the head and it is ready for market.

With later cabbage only the ripe heads are put on the market at the time or soon after they are cut. The unripe and loose heads are pulled with stems and roots on and stored for winter or spring marketing. Some ripe or nearly ripe heads for winter use are also pulled with stems on for storing. See Fig. 3.

Storing Cabbage. There are two methods of storing cabbage, namely, "heads down" and "heads up". The former method includes the heads ripe or nearly so for winter use. Furrows are plowed and the loose earth thrown out. The cabbage is placed in the furrow with the heads down and earth is shoveled or plowed over the heads and stems so only the roots are uncovered. If heavy freezing is feared, straw or manure should be thrown over the ridges, for it is best not to let the heads freeze much if it can be avoided.



Fig, 3 Cabbage stored for winter, Heads down in front. Heads up at the rear.

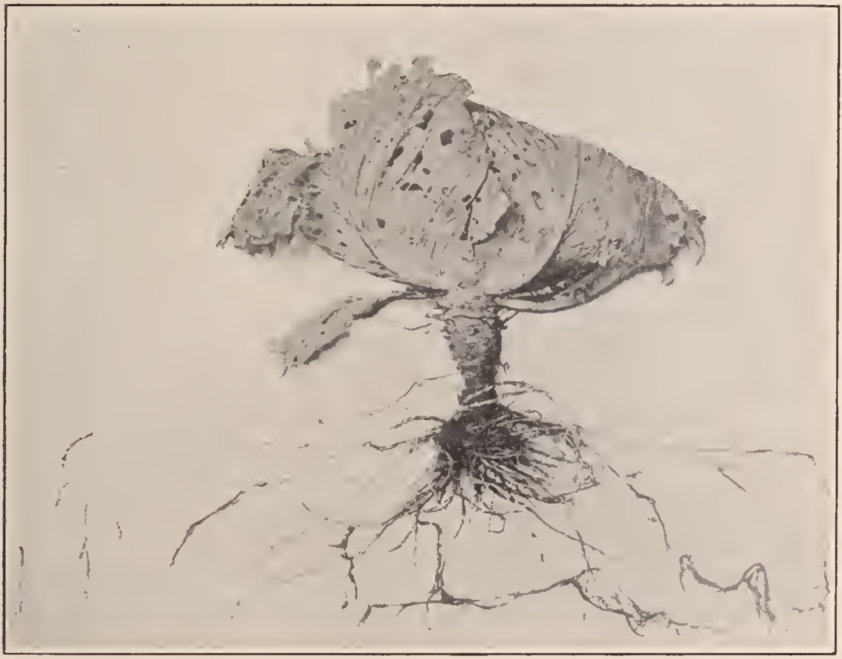


Fig 4, Showing root development of cabbage (roots were carefully washed out).

The unripe cabbage is stored "heads up" so that they may continue growing and developing. A furrow is plowed and the cabbage is set close together roots down in it, and earth is worked and tramped around the roots and stems. A second furrow is plowed throwing the earth on the stems of the first row. Beds six or eight rows wide may be made this way. Care must be taken that the stems are buried up to the heads, for hard freezing injures them. If properly stored the cabbage will continue to grow and will be in good condition for late winter or spring use. Pine boughs or some light material should be thrown over the beds to protect the heads from bright sunshine and harsh winds, but not enough need be used to protect from frost, as freezing does not injure the heads in this unripe condition.

Varieties. The very early kinds are generally of oval or oval pointed shape of which Early Jersey Wakefield is the most popular and satisfactory. Other good ones are Charleston Wakefield, Early York and Early Winningstadt. The very early flat-headed ones are small and not so satisfactory as the Wakefield type. A few of the good second early varieties are Early Spring, Early Flat Dutch and All-Head Early; these are of the Early Flat Dutch type.

For midseason crops the flat-headed varieties are the only ones used, Succession and All Seasons being among the best.

There are many good late varieties and it must be determined which will do best in any certain locality. In localities with a reasonable amount of moisture and hot sun, most of the late varieties do well. Varieties with fringed leaves of a bluish-green color seem to stand the vicissitudes of moisture, temperature and soil conditions better than other types. Some of these are Landreth Market Gardener, Large Late Flat Dutch, Landreth Surehead, Landreth Autumn King and Burpee Autumn King.

The late Flat Dutch varieties and strains come next in favor and reliability; they have light green colored leaves not fringed.

In some sections the Danish Ball Head is the most profitable late variety; it is used especially for making sauerkraut. It cannot stand heat and moisture.

The Savoy, or crumpled leaf varieties, are very sweet and delicious, but are not much grown. American Drumhead Savoy and Netted Savoy are good ones.

The red varieties are used somewhat for pickling and making slaw. The Red Dutch and Mammoth Rock Red are very good.

Seed Growing. The plants for seed growing should not have hard heads when they are pulled. They are stored "heads up" and covered with enough mulching material to protect from frost. About May 1, they are planted in rows four feet apart and three feet apart in the row. Seed stalks are sent up through the heads and as the seed pods turn yellow and ripen the stalks are cut and hung in an airy room to dry, after which the seed is thrashed out.

Cabbage stems will send up seed stalks and they are sometimes used, but seed so produced is considered inferior and this method should be discarded.

INSECTS

The cabbage maggot, *Pegomya brassicæ,* works on all plants of the cabbage or mustard family. Eggs are laid on the soil near the plants and the maggots crawl to the rootlets, upon which they feed, and then they burrow into the stem. There are two broods.

Remedy. A tarred paper card around the plant prevents the female from laying eggs near the plants and the maggots from reaching the roots. Crude carbolic acid, one pint emulsified in one gallon of water and then diluted to thirty gallons, is used around plants each week until May 15. Kerosene emulsion, 15 per cent, poured around plants is also beneficial.

The imported cabbage butterfly, *Poutia rapæ,* is one of the most common insects. It is the pale yellow butterfly hovering around mud holes, cabbage fields, etc. Eggs are laid on all plants of the mustard family and the caterpillars are ravenous feeders.

Remedy. Use Paris green, one pound, and lime, four pounds, in fifty gallons water until the heads are two-third grown or use Paris green in Bordeaux mixture. Spray as often as is necessary. Paris green may also be mixed with lime dust, road dust, land plaster and flour, and be sprinkled on the plants. Hellebore, one ounce to two gallons of water, should be used after the heads are two-thirds grown.

The cabbage plusia, *Autographa brassicæ,* works similarly to the insect above. The caterpillars are dark green with white stripes.

Remedy. See imported cabbage butterfly.

The zebra caterpillar, *Mamestra trifolii,* is distinguished by a pinkish stripe along each side. They eat the leaves and bore into the heads and stems at night and hide under clods of earth or stones during the day.

Remedy. Same as above.

The harlequin cabbage bug, *Murgantis histrionica,* is very destructive at times and attacks all plants of the mustard family and almost everything else green when this supply gives out. It is bright red with yellow or black mottling and sucks its food from the plants.

Remedy. Plant trap crops such as kale or mustard in the cabbage, cauliflower or other crop in this family, and the bugs will go to the trap crops, where they may be sprayed and killed with pure kerosene. These trap crops should be planted late as well as early.

Clean cultivation and the destruction of weeds and rubbish tend to reduce the numbers of this bug.

DISEASES

The black rot, *Pseudomonas campestris*, shows first by darkening the leaf veins. It causes one-sided, dwarfed or rotten heads.

Remedy. No reliable remedy is known. The seeds may be soaked for fifteen minutes in a solution of formalin, 1 part to 250 of water, or in a solution of corrosive sublimate, 1 part to 1000 parts of water.

Use only strong healthy plants and land well drained and not infested. Destroy diseased plants.

The club root or club foot, *Plasmodiophora brassicæ*, causes the roots and stems to become swollen and distorted. The other plants in the cabbage family are similarly affected and the fungus lives on such weeds as mustard, shepherd's purse, peppergrass, etc.

Remedy. Do not use ground once infested as the disease spores live in the soil many years. Use clean, well drained soil. Apply 75 bushels of fresh stone lime per acre on infested ground plowed in the fall, work the lime into the ground. Destroy diseased plants.

The wilt, *Fusarium sp.*, is caused by a fungus which attacks the roots causing the leaves to wilt and drop. The disease spores live in the ground.

Remedy. Destroy diseased plants and use land not infested with this disease. No good remedy is known.

The downy mildew, *Peronospora parasitica*, is sometimes present on plants in the seed bed, but may appear on the outer leaves of older plants.

Remedy. In the seed bed use less water and spray with Bordeaux. In the field use Bordeaux.

The soft rot is a bacterial disease which usually follows the fungous diseases mentioned and causes the heads to rot and become foul smelling.

These diseases attack other plants in the cabbage family and are combated as mentioned above.

THE CHEMICAL COMPOSITION OF THE CABBAGE PLANT

By H. J. Patterson

As the cabbage crop is of considerable commercial importance to Maryland and many questions were asked from time to time as to the relation of the crop to soil exhaustion, and the value of the refuse portions both for feeding and fertilizing purposes, it was thought desirable to make a fairly complete chemical study of the crop.

The analyses reported herewith were made in 1893, and they have awaited the publication of a bulletin on this crop. The samples analyzed represent a number of average mature plants, or plants with heads which are in the best condition for market.

The results of the chemical analysis are given in the following tables:

Dry Matter and Principal Mineral Constituents of Different Parts of the Mature Cabbage Plant

COMPONENTS.	HEADS.		REFUSE, LEAVES AND STALK.		ROOT.	
	Per cent.	Yield per acre pounds.	Per cent.	Yield per acre pounds.	Per cent.	Yield per acre pounds.
Water	98.50	13790	91.02	8191.8	83.29	937.0
Dry matter	1.50	210	8.98	808.2	16.71	188.0
Total	100.00	14000	100.00	9000.0	100.00	1125.0
Organic matter	1.29	180.6	5.40	486.0	14.21	159.9
Mineral matter	0.21	29.4	3.58	322.2	2.50	28.1
Dry matter	1.50	210.0	8.98	808.2	16.71	188.0
Pure ash	0.20	28.0	1.58	142.2	1.53	17.2
Sand	0.01	1.4	2.00	180.0	0.97	10.9
Crude ash	0.21	29.4	3.58	322.2	2.50	28.1
Lime (CaO)	0.019	2.7	0.441	39.7	0.107	1.2
Magnesia (MgO)	0.005	0.7	0.060	5.4	0.057	0.6
Phosphoric acid	0.023	3.2	0.080	7.2	0.111	1.2
Potash (K_2O)	0.087	12.2	0.402	36.2	0.762	8.6
Soda (Na_2O)	0.001	0.1	0.052	4.7	0.082	0.9
Iron and Aluminum	0.031	4.3	0.021	1.9	0.025	0.3
Chlorine	0.010	1.4	0.018	1.6	0.075	0.8
Sulphur (SO_3)	0.056	7.8	0.035	2.8	0.030	0.3
Sand	0.010	1.4	2.000	180.0	0.97	1.0
Nitrogen	0.065	9.1	0.227	20.4	0.352	4.0

Food Constituents in Heads and Refuse Cabbage

	HEADS.		REFUSE MATTER.	
	Per cent.	Yield per acre.	Per cent.	Yield per acre.
Water	98.50	13790.0	91.02	8191.8
Ash	0.21	29.4	3.58	322.2
Protein	0.41	57.4	1.42	127.8
Crude fiber	0.38	53.2	1.32	118.8
Nitrogen-free extract	0.46	64.4	2.41	216.9
Fat	0.04	5.6	0.25	22.5
Total	100.00	14000.0	100.00	9000.0

These results would indicate that cabbage is a very watery food and contains little dry matter, but that the relative amount of protein in the dry matter would class it as relatively more nutritious than is usually recognized.

Statistics of the eleventh census show that there are over 77,000 acres devoted to the growing of cabbage in the United States and about 4,000 acres in Maryland. Each acre of cabbage costs on the average $21 for labor and cultivation and gives a net profit of $118. The same statistics also state that there is on the average $33 worth of fertilizers applied to each acre of cabbage.

The results in the above tables show the different fertilizing elements found in the various parts of the cabbage plant to be as follows:

Fertilizing Material Found in the Different Parts of Cabbage Plants.
(Per cents in fresh materials.)

	HEADS	REFUSE LEAVES	ROOT
	Per cent	*Per cent*	*Per cent*
Phosphoric acid	0.023	0.080	0.111
Potash	0.087	0.402	0.762
Nitrogen	0.065	0.227	0.352
Lime	0.019	0.441	0.107

An average crop of cabbage will yield per acre 4000 mature heads weighing 3½ pounds each, or 14,000 pounds.

The refuse matter from the 4000 mature heads and 500 unmatured plants, averaging 2 pounds each, will yield 9000 pounds of matter per acre. The 4500 roots, averaging ¼ pound each, will allow 1125 pounds of vegetable matter to remain in the land.

Combining the above figures we find that each acre of an average crop of cabbage requires during its growth the following amounts of plant food:

Pounds of Fertilizer found in Cabbage from one Acre

	HEADS	REFUSE	ROOTS	TOTAL
	Pounds	*Pounds*	*Pounds*	*Pounds*
Phosphoric acid	3.2	7.2	1.2	11.6
Potash	12.2	36.2	8.6	57.0
Nitrogen	9.1	20.4	4.0	33.5

This means that the cabbage crop of the United States requires in its growth at least 450 tons of phosphoric acid (P_2O_5), 2195 tons of potash (K_2O), and 1290 tons of nitrogen (N); of these amounts 123 tons of phosphoric acid, 470 tons of potash and 350 tons of nitrogen are sold off the farms in the heads. The balance is left on the land as refuse, either to be fed to stock or plowed under for a succeeding crop.

To replace the amount sold off the land in the heads it would require an equivalent of about the following amount of commercial fertilizers:

870 tons of phosphate rock of 14 per cent grade, 940 tons of muriate of potash of 85 per cent purity, 2100 tons of nitrate of soda of 95 per cent purity.

Or in other words it would require about 4000 tons of a fertilizer analyzing:

3 per cent phosphoric acid,
12 per cent potash,
9 per cent nitrogen,

to replace the plant foods sold in the heads. Of these amounts over 50 per cent would be needed in the vicinity of New York and Philadelphia, 6 per cent in Maryland and 13 per cent in the Norfolk truck section. But in feeding a crop there must be available plant food in proportion to the amounts needed in the entire plant without reference to that which is found in the edible or marketable portion. These proportions would be 3 per cent phosphoric acid, 14 per cent of potash and 8 per cent of nitrogen.

The proportions of plant food necessary to be furnished in a commercial fertilizer must always be modified with reference to the soil to which it is to be applied, and while it is but rarely desirable to maintain the above proportions, yet taking the average soils used for cabbage culture, it will be found that most of the so-called truck and cabbage fertilizer on the market contain entirely too little potash and nitrogen in proportion to the phosphoric acid. With a crop like cabbage it is desirable to grow it quickly and to keep it growing to ensure a good quality, and to do this there must be plenty of available plant food constantly at hand.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 134 APRIL, 1909

BROWN TAIL MOTH, HOUSE FLY AND MOSQUITO

BY THOS. B. SYMONS

INTRODUCTION

In view of the fact that the overwintering nests of the notorious brown-tail moth have been found on trees and plants imported into this State during the past few months and because of the extreme likelihood of its escape, it is deemed wise to give the public a brief description of the insect in order that its establishment, if such is accidentally accomplished during the coming season, may be more readily detected and immediate steps taken towards extermination.

The comparatively recent awakening of the public mind to a realization of the important rôle that insects play in disseminating some of our most common and virulent diseases suggests a brief discussion of one of our most common household pests, the common house fly or, as Dr. Howard fittingly designates it, "typhoid fly." Good health is the greatest asset of which any locality can boast, and it is with a view of suggesting better sanitary conditions around the farm and home looking towards a decrease in the abundance of this pest that a brief discussion of this insect is here given.

During the summer of 1904 this department commenced an investigation of the mosquito pest in Maryland. For the want of funds the work has not been continued as was anticipated, although observations and collections have been made in different parts of the State during the past four years as opportunity afforded. While the State has not seen fit to appropriate money for a thorough investigation of the problem, yet it is possible for much good to be accomplished by individual effort in the control of the pest. Inasmuch as bulletin No. 109 issued in May 1906 is now out of print it is thought desirable to again call the attention of the people of the State to the importance of the problem as a whole and particularly to the control of the common house mosquito.

This bulletin therefore may well be considered as a word of warning to the people of Maryland to prevent the establishment of the brown-tail moth in the State and as far as possible prevent diseases being disseminated by the house fly and mosquito.

The writer disclaims any originality for the contents of this bulletin as for the most part the description of the insects herein mentioned are a compilation from various writers, particularly as regards the discussion of the brown-tail moth.

BROWN-TAIL MOTH

(*Euproctis chrysorrhœa*)

This is one of the oldest caterpillar pests of Europe and it is very strange that a general importation of the nests such as has occurred during the past winter has not occurred heretofore.

This European pest according to Howard was first observed in this country in Massachsuetts in the early nineties, being probably imported upon some rose stock. From its introduction to 1898, according to Sanderson, no direct effort was made by the State to retard its spread, although the legislature had passed a law requiring local authorities to suppress the insect. In 1898 an appropriation of $10,000 from the gypsy moth funds was made to the Massachusetts Board of Agriculture, to suppress the brown-tail moth. From 1900 to 1904 no concerted effort through State funds was made against the gypsy and brown-tail moths in Massachusetts. Individual effort by local towns and private parties met with only partial success. During this interval the two pests gained a tremendous headway and it was necessary for the State of Massachusests through its legislature of 1905 to appropriate $150,000 per annum to aid in the control of the gypsy and brown-tail moths. The following legislature 1906 increased the appropriation to $225,000. On account of the habits of the two moths, the brown-tail spreads more rapidly than the gypsy moth and at the present time, therefore, the former covers a more extended territory in New England than the latter. At this writing there are approximately $500,000 appropriated by the United States Government and the States of Massachusetts, New Hampshire, Connecticut, Maine and Rhode Island for work in the suppression of these two insects. In addition the enormous expense to towns, villages and private individuals through their effort to protect their property and the loss of timber and the depreciation of real estate will bring the cost of the insects in New England states already into millions of dollars. It therefore behooves every one in this State to spare no means to prevent their establishment in Maryland.

Description and Life History

There is but one generation of the brown-tail moth annually in New England. The insect winters as a tiny larva or caterpillar within a web or nest made of silk and leaves woven together tightly. The nests will vary in size usually from three to four inches in length and will contain two hundred or more caterpillars (see Figs. I and II).

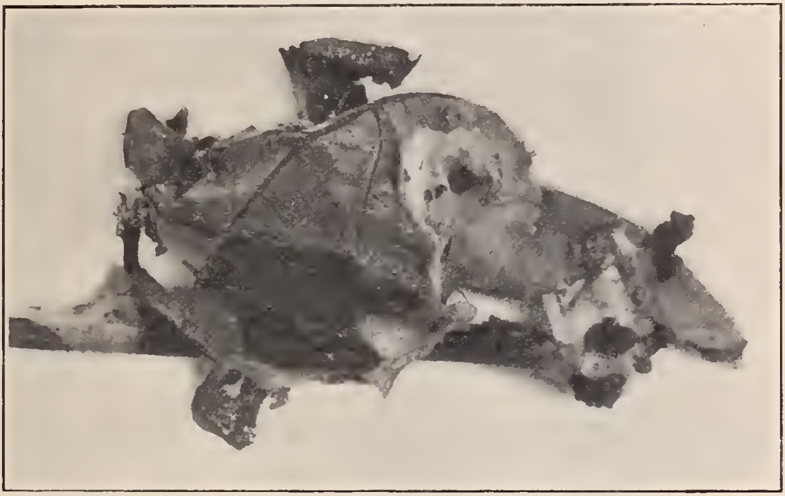


Fig. 1 Nest of the brown-tail moth taken from an oak tree in Massachusetts. Photograph by L. M. Peairs.

These nests are securely attached to the tips of trees or plants on which the caterpillars were working before hibernation.

In early spring, as soon as the buds of fruit and shade trees appear, according to Howard, these one-fourth grown caterpillars emerge from their winter quarters and immediately commence feeding upon the buds and blossoms and later the foliage. The young caterpillar is of a

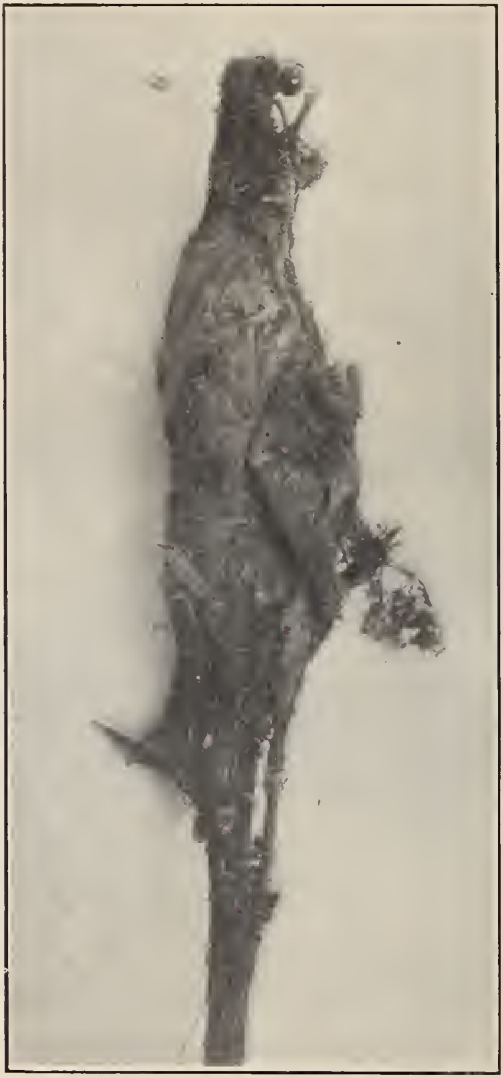


Fig. 2 A characteristic nest of the brown-tail moth found on imported stock in Maryland. Photograph by L. M. Peairs.

blackish color and covered with very small hairs. The full-grown larva is about two inches long, reddish brown in color, with a broken white stripe on each side and two red dots in the back near the hind end. The body is covered with numerous tubercles bearing long barbed hairs. The tubercles along the back and sides of the abdomen are thickly covered with short brown hairs in addition to the long ones.

The full-grown larva changes to a pupa within a cocoon which it previously makes with silk and leaves. According to Howard these cocoons may be in groups or singly in some secluded spots or at the tips of branches of trees on which they have fed. The cocoon is so loosely made that the pupa may be seen through it. According to Sanderson the pupa stage lasts about twenty days, the adult moths emerging in the early part of July.

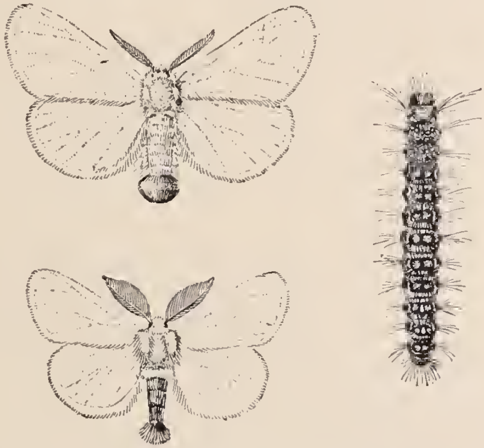


Fig. 3 The brown-tail moth (*Euproctis chrysorrhœa*); Female moth above male moth below, larva or caterpillar at right, slightly enlarged; after Howard Farmers' Bulletin, No. 264, United States Department of Agriculture.

The moths of both sexes are pure white with the exception of the abdomen, which is dark brown (see Fig. 3). The tip of the abdomen of both sexes, more pronounced in the female, bears a small tuft of brown hairs, from which the insect gets its name. The female moth has an expanse of about one and one-half inches while the male is somewhat smaller. The moths are strong fliers and are readily attracted to lights.

Howard states that the moths commence laying eggs usually on the underside of leaves toward the tips of the limbs soon after emerging. The eggs hatch in about three weeks. The young caterpillars feed upon the surface of the leaves, skeletonizing them and when abundant causing the foliage to turn brown as if blighted or scorched by fire.

In early fall the young larvæ commence spinning their nests within which they pass the winter.

Means of Distribution and Food Plants

According to the various writers the principal spread takes place through the flight of the moths just after emergence. This occurs in the night as the moths are seldom seen flying in the day time. The fact that the moth is a strong flier accounts for its greater spread in the New England states than the gypsy moth. The direction and force of the wind at the time of flight will to a great extent determine the spread of the pest.

In addition to its power of flight the insect in its larva or caterpillar state can, of course, be distributed by various means. Especially is this possible in the transporting of trees and plants which contain the over-wintering nests of the insect.

The injury caused by this insect where established can be hardly estimated in terms of dollars and cents. The foliage of all fruit trees, especially pear and apple where available, seems to be the preferred food of the caterpillars, but they freely attack all shade trees including the oaks, maples, elm and the like, in fact Sanderson states that all fruit, shade and forest trees may be attacked with the exception of pines, spruces and other conifers. Fernald and Kirkland published in 1903 a list of eighty different food plants of this pest. This extensive range of food plants shows the possibilities of severe damage to our trees and shrubs if its establishment is accomplished. It is possible that the pest might be even more destructive in the south than it is now in the New England states.

Brown-Tail Rash

In addition to the severe injury that this pest will occasion to fruit, shade and forest trees, and the consequent enormous cost of fighting it, there is another feature connected with its presence that is very troublesome if not alarming, that is, danger to the health of people.

As mentioned in the description of the insect, the larva or caterpillar bears tiny hairs which are barbed as shown in Fig. 4. When the caterpillars molt these barbed hairs are shed with the skin. Upon drying, these skins and hairs float about in the air and are a source of constant trouble to persons living in an infested district. When the caterpillars' skins, or even loose hairs, come in contact with the skin they cause a severe irritation. Howard states "that a large part of the popular feeling in New England that the brown-tail moth must be exterminated is due quite as much to the prevalence and annoyance of this rash as to the loss of vegetation from the work of the caterpillar."

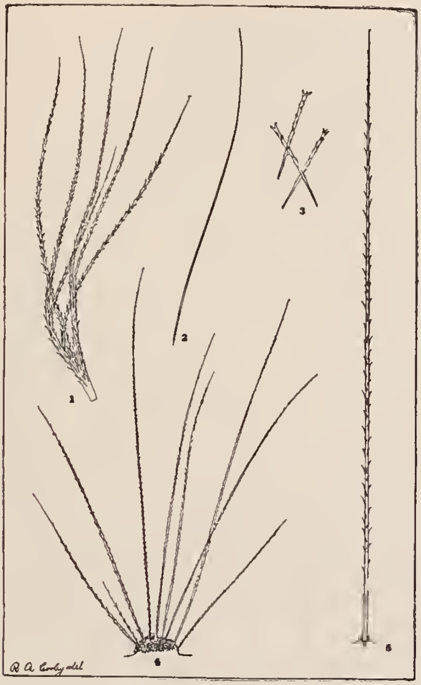


Fig. 4 Various forms of hairs from brown-tail moth caterpillar. (After Fernald and Kirkland. Through courtesy of Sanderson.)

Work in Maryland

The first intimation that the brown-tail moth nests were being found on imported nursery stock came through Mr. Geo. G. Atwood, Chief, Bureau Horticulture, Board of Agriculture of New York, who reported the finding of the nests on stock imported from France. Acting immediately upon these advices, the nurserymen of the State were requested to hold unopened all imported shipments of seedlings or other stock received until the arrival of a representative of this department at the nursery in order that all the stock could be carefully inspected. It is pleasing to acknowledge the hearty coöperation of all the nurserymen of this State with the department in our efforts to prevent the escape of a single nest.

In all about 1,150,000 seedlings and other stock have been carefully inspected and a total of 700 nests of the brown-tail moth have been found and burned. This will give an idea of the extra amount of work that was forced on this department whose funds for even the regular amount of work are very limited. However, no pains could be spared to prevent the escape of the pest in the State. That we have been entirely successful is by no means certain. For in the examination of such a large amount of stock and with the possibility of individual ship-

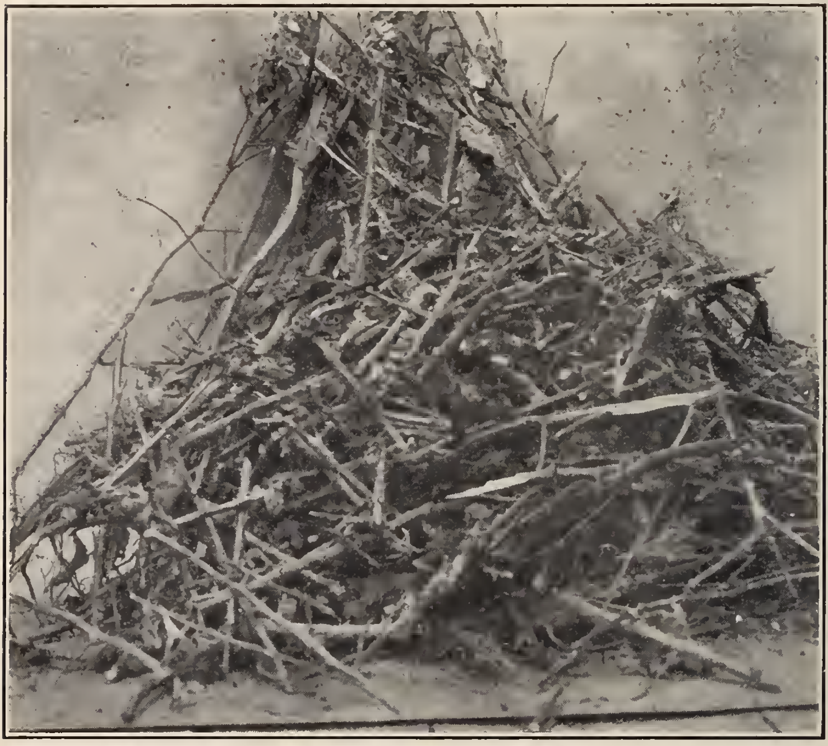


Fig. 5 A mass of imported trees and seedlings showing numerous nests of the brown-tail moth attached. Photograph by L. M. Peairs.

ments arriving of which we have no knowledge, there is indeed a strong possibility of an outbreak of the pest some place in the State during the coming season. It is for this reason that this discussion of the pest is brought before the people in order that all may be on the lookout for its first appearance in the larva stage.

Remedies

With this as with other insect pests whose life histories are understood we can attack it at its weakest point. With this pest undoubtedly the easiest and practically the only effective means of artifical control where established is by cutting off the over-wintering nests during the late fall, winter or early spring and destroying the tiny larvæ within. This of course can be supplemented by spraying with an arsenical mixture, when the larvæ appear on the foliage in spring. When young, according to Howard, the larvæ may be killed with the ordinary strength of paris green or arsenic of lead, but when the larvæ are half grown or larger, according to Sanderson, 5 pounds of arsenate of lead to 50 gallons of water is necessary to prove effective.

If it should happen that the pest appears in any locality of this State during this or succeeding years, it will be the duty of the State authorities, in coöperation with private individuals, to spare no means in immediately undertaking to exterminate it.

It is hoped that the people of the State will keep a sharp lookout for the first appearance of a strange caterpillar that may be devouring foliage of any kind of tree and upon its detection immediately notify the State authorities in charge of such work.

DISEASE-CARRYING INSECTS

The important rôle that insects play in the dissemination of disease has only during comparatively recent years been appreciated by the public. The popular feeling towards house flies and mosquitoes has too long been simply that they are inevitable nuisances which must be put up with. Their effect upon the health of a community has not been questioned or considered. But, now that we have any quantity of proof of the ability of these pests to transmit or disseminate some of our most common diseases, we are able to explain many unanswered questions as to the source of infection of numerous outbreaks of these diseases. Further study of this subject will no doubt bring to light much additional information in regard to the ability of many of our common pests other than those mentioned above to disseminate or transmit disease among human beings.

THE TYPHOID OR COMMON HOUSE FLY

(*Musca domestica*)

The change of the name of this the most common of all household pests from "house fly" to "typhoid fly," as suggested by Dr. L. O. Howard in Bulletin 78 of the United States Department of Agriculture, is considered very appropriate and desirable, inasmuch as it is established by abundant evidence that this pest is now largely responsible for the spread of that dreaded disease "typhoid fever." It is well known that the germ of typhoid fever may be in the human system several weeks before it is detected and also for several weeks after all symptoms have disappeared and the patient apparently well. The excreta of such persons which may be in an open privy, or in many cases in country districts located anywhere around the outbuildings, is visited by the fly, whose feet and body are particularly adapted to carrying germs. This same fly after visiting such places may immediately return to the house of the sick or that of a neighbor and be seen crawling in the kitchen or dining room over the food that is prepared to be eaten by the unaffected persons. Not only may the fly disseminate the disease to the healthy within the family of the sick or that of close-by neighbors, but there is every opportunity for the same infected fly to visit the village or city store where foods are exposed and thus spread the disease to those families who purchase them. The butcher wagon of the country or the trolley or express train carrying food such as sacked meat, etc., may easily become factors in the dissemination of this disease if such carriers are loaded at or visit points where conditions are favorable for visitation by infested flies. The house fly is connected with the dissemination of intestinal diseases other than typhoid fever. Dr. Jackson of New York points out that the immunity from diarrhea of breast-fed babies and the frequency of its occurrence among artificially fed babies indicates strongly the food as a medium of transmission, and further states that in his extended study of this problem along the water front of New York City during 1907 he found that the prevalence of these diseases among children and adults corresponded to the prevalence of flies. Further Dr. Felt in a recent paper states that "It is well known that flies feed upon sputum. Experiments by Lord recorded in the Boston Medical and Surgical Journal show that flies may inject tubercular sputum and excrete tubercular bacilli, the virulence of which may last for at least fifteen days. He considers the danger of human infection from this source to lie in the injection of fly specks on food, and suggests that during the fly season great attention should be paid to the screening of rooms and hospital wards containing patients with tuberculosis and laboratories where tubercular material is examined."

In Bulletin No. 78 of the Bureau of Entomology, United States Department of Agriculture, which should be read by every person in the State, Dr. Howard cites among other interesting data that Dr. G. N. Rober estimates that the decrease in the vital assets of the country through typhoid fever in a single year is more than $350,000,000.00. Dr. Howard says that the house fly as an important agent in the spread of this disease is responsible for a considerable portion of this decrease in the vital assets As an agency in the spread of other intestinal diseases it must be charged with a great addition to this sum. Yet it is allowed to breed unrestricted all over the United States.

While the house fly cannot of course be charged exclusively with the dissemination of such intestinal diseases, the writer fully believes that no single factor aids in their spread during the fly season to a greater extent than this common pest of mankind.

Further than this the house fly is a vexatious nuisance in itself. Its presence in a house causes additional cleaning to paint work, walls, pictures, etc., as well as being a continual nuisance to the inhabitants whether asleep or awake in the day time. Dr. Howard estimates that "The house fly with mosquitoes necessitates an annual outlay for window and door screens in the United States of not less than ten millions of dollars." Even this amount is comparatively nothing to what should be spent for this purpose without there is and what we hope will be in the near future a united campaign conducted by the people in preventing the pest from reproducing. This then suggests the life history of the insect and how it can be combated.

Description and Life History

The common house fly (*Musca domestica*) is a medium sized fly, grayish in color with its body somewhat streaked with blackish gray. As previously mentioned, its body, but more especially its legs and feet are covered with minute hairs. Its mouth parts are formed for lapping and not biting, yet many people think of the house fly as being able to bite. This is no doubt due to the presence in the houses of one of the

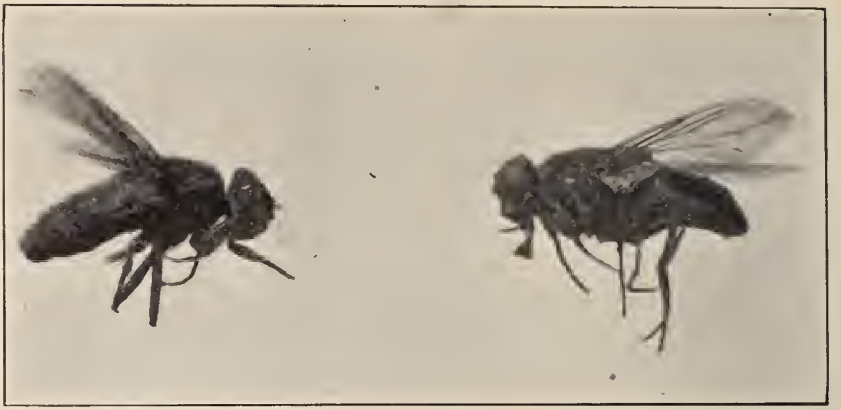


Fig. 6 House fly to the right, showing lapping mouth parts. Stable fly to the left showing piercing mouth parts. Enlarged. Photograph by L. M. Peairs.

stable flies whose mouth parts are formed for piercing. Fig. 6 illustrates the mouth parts of these flies.

The insect winters in the adult state, hiding in houses or other out-of-the-way places. At the approach of warm weather the flies come forth from their hiding places and commence to lay their tiny white eggs. These eggs commonly are deposited in horse manure as this seems to be the preferred larval food and it is from this source that

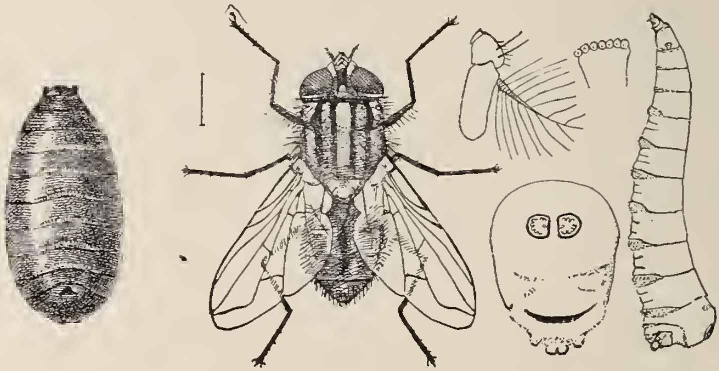


Fig. 7 The typhoid or common house fly (*Musca domestica*). Puparium at left; adult next with enlarged antenna, larva and enlarged parts at right. Enlarged after Howard, Bulletin No. 30, New Series, Division Entomology, United States Department of Agriculture.

the majority of the house flies come. Eggs may also be laid in human excreta and in decayed vegetable and animal matter.

Dr. Howard found in midsummer in the vicinity of Washington that a female fly lays about 120 eggs which hatch in about eight hours. The white larvæ or maggots which are pointed at one end and blunt at the other grow rapidly and change to a pupa in four or five days, the adult emerging from the pupa in about five days, thus completing their life history in about ten days. Fig. 7 shows the different stages of the insect and Fig. 8 shows a number of larvæ or maggots in a pile of horse manure. Howard states that "there is abundance of time for

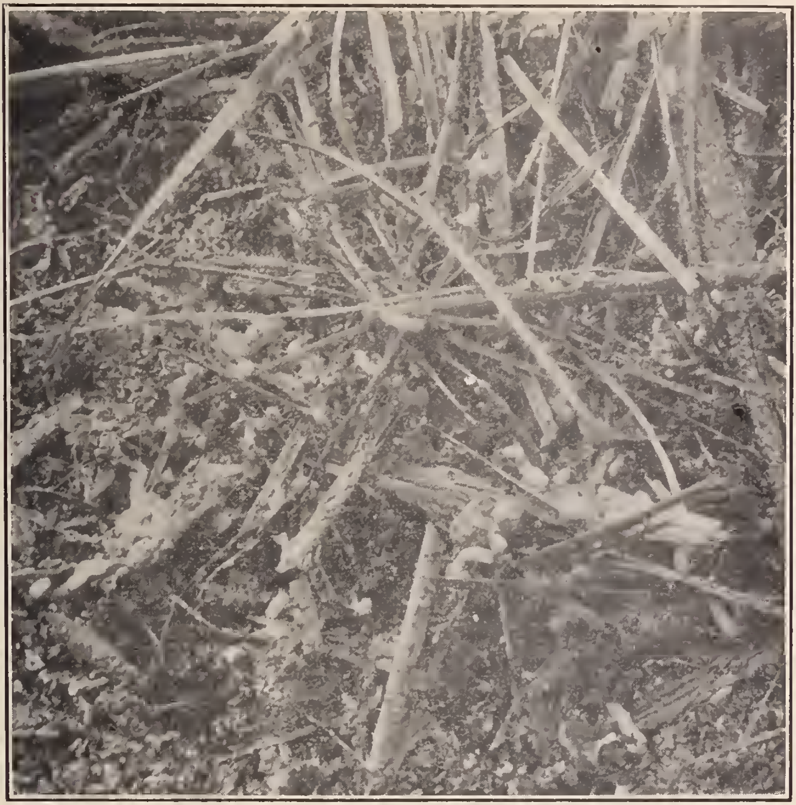


Fig. 8 A mass of horse manure showing larvæ (maggots) of the common house fly. Photograph by L. M. Peairs.

the development of twelve or thirteen generations in the climate of Washington every summer."

MEANS OF CONTROL

On account of their omnipresence the task of getting rid of house flies would seem too great. Fortunately the matter is much simpler than we might expect. It simply means a proper care in the disposal of their preferred larval food, horse manure, and the maintenance of proper sanitary conditions around the house and vicinity. In cities, and especially in towns and villages where sewerage systems are absent and where adequate means of sewerage disposal are rarely present, such conditions should be governed through an ordinance by the Boards of Health or other designated officials.

Little will be accomplished by a few persons in a town or community in preventing them gaining access to their breeding places, if some neglect this duty, for a single pile of horse manure allowed to stand in the open will serve to furnish flies for a whole neighborhood. The greatest good therefore will result from the combined efforts of all persons keeping stables in a community in either having the manure removed from the stables and vicinity twice a week or keeping the manure in a screened portion of the stable, treating it after each addition with air-slaked lime. Dr. Howard has shown how the presence of flies in a neighborhood of the city of Washington was materially reduced by such treatment of the manure from a horse stable nearby. The task of combating the pest in rural districts and around farm houses is largely an individual one and its presence in large numbers or to a limited extent will depend upon the sanitary conditions that are maintained around the house and barn. It is good farming practice to remove the fresh manure from the barns to the fields at least twice a week and if this is done and other sources of breeding material are protected the pest will be largely mitigated around the home.

As indicated heretofore the question of protection of privies or open deposits of human excrement from access of flies either for breeding or visitation is of the utmost importance, for, as stated, it is by this means that the fly assembles the germs of disease and distributes them to any exposed food. It cannot be too strongly urged that all such places be constructed as sanitary as possible and free use of earth or lime be made for covering all deposits. The dropping of human excrement in the open in our towns and villages or around our farm homes should never be tolerated. It is not to be presumed that even under the best regulated conditions it will be possible to entirely eradicate this most common pest on account of the ever abundant field for its development. It therefore behooves every housekeeper to keep at least all eatables protected from flies. Too often it will be seen that the parlor is kept dark or screened from flies while they may be present in great numbers in the kitchen or dining room crawling over all food being prepared for consumption.

Therefore screens should be freely used to prevent the flies gaining access to the home; also strict sanitary measures employed in disposing of waste material.

The use of sticky fly papers or other patented means of catching flies that have accidently entered the house is the easiest means of catching them. Fumigation with pyrethrum (Persian insect powder) is recommended when the flies are present in great numbers.

These measures should particularly be adopted by our merchants and those conducting eating houses, markets and dairies, etc., who serve the public with food that is likely to be contaminated by the dirty germ-laden house fly.

THE MOSQUITO PEST

To the great majority of our people, the mosquito like the house fly is looked upon as an unavoidable nuisance, over the presence of which we have no control. Seldom do we stop to think or investigate sources of this troublesome pest. We simply try to keep them out of the house by screens or other protection and if some do gain access an effort is made to kill them one by one whenever opportunity affords. When occurring in enormous numbers in country districts, especially serving as a continual irritant to man in his daily labors and as a source of constant annoyance to domestic animals they are simply tolerated, and the hope is expressed that the wind will change or that the insect will take a notion to lessen its attack. Moreover, if one of the family is attacked by chills and fever, even with a mild attack of malaria fever, it is the usual custom to attribute such sickness to unusual exposure to the night air or the contaminating influence of swampy areas during the spring and summer months. In addition to acting as an agent in the transmission of specific diseases any species of mosquito may disseminate blood and intestinal diseases by inflicting wounds with a proboscis contaminated with fecal bacteria.

While only a few particular species of mosquitoes exact a toll of human lives through transmission of disease and many species cause pecuniary loss by depreciation in real estate by virtue of their presence, it would perhaps be better if the mosquito should be an important factor in causing damage to some of our agricultural crops, for in such case active measures would be taken throughout the land to prevent their appearance and extermination of the pest would be vigorously prosecuted as is the practice with other insect pests. Unfortunately, this is not the case and such measures looking toward their control or extermination have only been undertaken where their presence has affected the financial interests of the communtiy or where the people as a whole have been educated to the point of appreciating the comparative ease with which freedom from the pest is obtainable.

It is hoped that in this age of progressiveness our people will appreciate the possibilities of protection of human life; the great increase in land valuation and the benefit to man and animals by conducting, in the near future a State-wide campaign looking towards the control and extermination of mosquitoes.

Malaria

Among the revelations of medical science of recent years no one was more astounding to the popular mind or broader in its effect upon mankind than the finding through scientific investigation that the malaria fever can only be contracted through the bites of species of mosquitos belonging to the genus Anopheles. Thus it will be seen that this, the most common and widespread of infectious diseases and one whose cause was attributed to innumerable sources, can be prevented by the extermination in inhabited districts of the species of mosquitos responsible for its development.

It would be difficult to estimate the economic loss to the State of Maryland from malaria. Simply enumerating the number of deaths from the disease would only partially state the case. As a matter of fact a comparatively small per cent die of malaria directly. But many ultimate deaths are brought on by complications which first originated in an attack of malaria. But the deaths resulting directly or indirectly from this disease comprise only a part of the economic loss which it represents. Dr. Howard in Bulletin 78 already referred to estimates that this productive capacity of individuals attacked by the disease is reduced at least one-quarter. He further states that "accepting this as a basis; and including the loss through death" which he approximates at three million in the United States annually, "the cost of medicines, the losses to enterprises in malarious regions through the difficulty of securing competent labor and other factors, it is safe to place the annual loss to the United States from malarial diseases under present conditions at not less than one hundred millions of dollars." Maryland undoubtedly gives her share of toll to malaria as from its climatic and topographical conditions, at least in the eastern, central and southern parts, the State offers many advantages for the development of malarial mosquitoes.

The preliminary investigations published in Bulletin 109 of this Station and observations since that date show that the districts in the State where the malarial mosquito breeds are extensive. Four species of the genus Anopheles have been found but the species Anopheles maculipennis is considered to be the most malignant in the transmission of malaria. Inasmuch as the mosquitoes of the genus Anopheles, while preferring grassy pools of clear, clean water, are found breeding everywhere in tin cans, troughs, etc., their numbers can be largely lessened by private or individual efforts at control.

Yellow Fever

It is only necessary to mention this dreaded disease in connection with this discussion on account of the possible importation of the yellow fever mosquito Stegomyia calopus into our domain through steamboats or other means of transportation. The findings of Dr. Finley supplemented by the investigation of the United States Commission and many other scientists show that yellow fever is carried by the above species of mosquito and that it constitutes the only known means by which the disease is spread. This species of mosquito is quite abundant in the Southern States and is likely to be imported at any time and if so, during summer months will reproduce very rapidly if favorable breeding places are available.

Maryland's Problem

Aside from the danger to health due to the presence of malarial mosquitoes the mosquito as a pest to man and beast is of such magnitude in many parts of this State as to be of sufficient moment to warrant immediate action on the part of the State government. The Maryland Weather Service reports that there are approximately 124,252 acres of fresh water swamps and 204,416 acres of salt water marshes out of a total area of 6,310,400 acres of land in the State. The proper drainage of this swamp land in itself offers an abundant field for development and the greatly increased assessed valuation would in a comparatively short period more than repay the necessary expense of the work, not to mention the lasting benefits which would accrue from the improvement of such lands and a corresponding growth of the community. This is doubly emphasized when it is realized that such work, together with individual effort, would largely mitigate the mosquito pest of a vicinity.

The foresight of such State policy has been conclusively demonstrated by our sister State New Jersey, where the State Entomologist is directing the expenditure of a $300,000 appropriation made by the State for mosquito control through drainage of her swamp lands. On a basis of cost in draining ordinary swamp lands which varies from $1.50 to $2.50 per acre in New Jersey, it would require about $500,000 to conduct the work in this State, but this sum while it seems large at first sight would soon be returned to the State by the improvement of such lands.

This department has been working on the problem to a limited extent with practically no available funds for the past four years. It is hoped that sooner or later the State government will be in a position to take up the problem and after a thorough investigation conduct drainage operations which will not only greatly improve the health and land valuation in such districts but will serve to remove this ever appearing mosquito pest.

As indicated in the introduction the real purpose of this discussion of the mosquito is to stimulate an interest in the individual as to the importance and ease with which the presence of this pest can be largely decreased around the home under normal conditions. It likewise applies to the city, town or village where the control of the pest is simply a local problem. The description and life history of the common house mosquito (Culex pipiens) taken from Bulletin 109 will serve to show the habits of those species that commonly breed in local communities.

THE HOUSE MOSQUITO

(*Culex pipiens*)

"This species is probably the most abundant one in the State for it is found in cities, towns and country districts in large numbers and is annoying as a persistent biter. The adult is a mosquito of medium size, the head being brown, with a few yellow scales and a yellow border to the eyes. The beak is brown, darker towards the apex, and somewhat thicker and shorter in the male than in the female; the thorax is brown, with many golden scales scattered over the surface; the abdomen is blackish brown, with yellowish moderate or narrow bands at the base of the segments. The mosquitoes vary considerably in size and color, but are easily recognized by the fact that they have no strikingly characteristic marking. It is the common, everyday brown mosquito (see Fig. 9).

The adult is persistent in its attempts to gain entrance indoors. Just at twilight on summer evenings it can be seen hovering against the sides of buildings and may rise to the second or third story, seeking entrance through crevices in screens or doors. It hibernates in the adult stage in any sheltered place about human habitations. Cellars, attics, stables, outhouses or closets may furnish it winter quarters. Hibernation begins early in the autumn, before breeding ends. It is said by some that only the impregnated female hibernates, but I have seen great numbers of males of this species in the early spring, before any breeding had occurred, apparently recovering from their long winter sleep.

Culex pipiens is not a migratory form and flies no further than is necessary to secure food or to find a suitable place to oviposit. Dr. Smith says that blood is not necessary for this species for the development of the ovaries.

In the spring, when warm weather has come, the hibernating females awaken, seek food and deposit their eggs. The female oviposits in early morning or at night in any suitable body of water. The eggs of this species are laid in egg boats or rafts, as illustrated in Fig. 10, each containing 300 to 400 eggs. The length of the life cycle is from 10 to 16 days in summer months.

The number of broods of Culex pipiens during the summer is indefinite and depends upon the favorableness of conditions. During warm, rainy seasons, when plenty of puddles exist, it breeds rapidly. A single rain barrel, as shown in Fig. 11, may produce hundreds of thousands of this annoying pest in a comparatively short time.

The larva is very active. The breathing tube is of moderate length and the larva hangs head down and at an angle with the surface of the water when breathing. This position is characteristic of most of the species of Culex, the Anopheles differing from them in resting flat on the surface of the water.

The larvæ feed upon animal and vegetable matter in the water. In

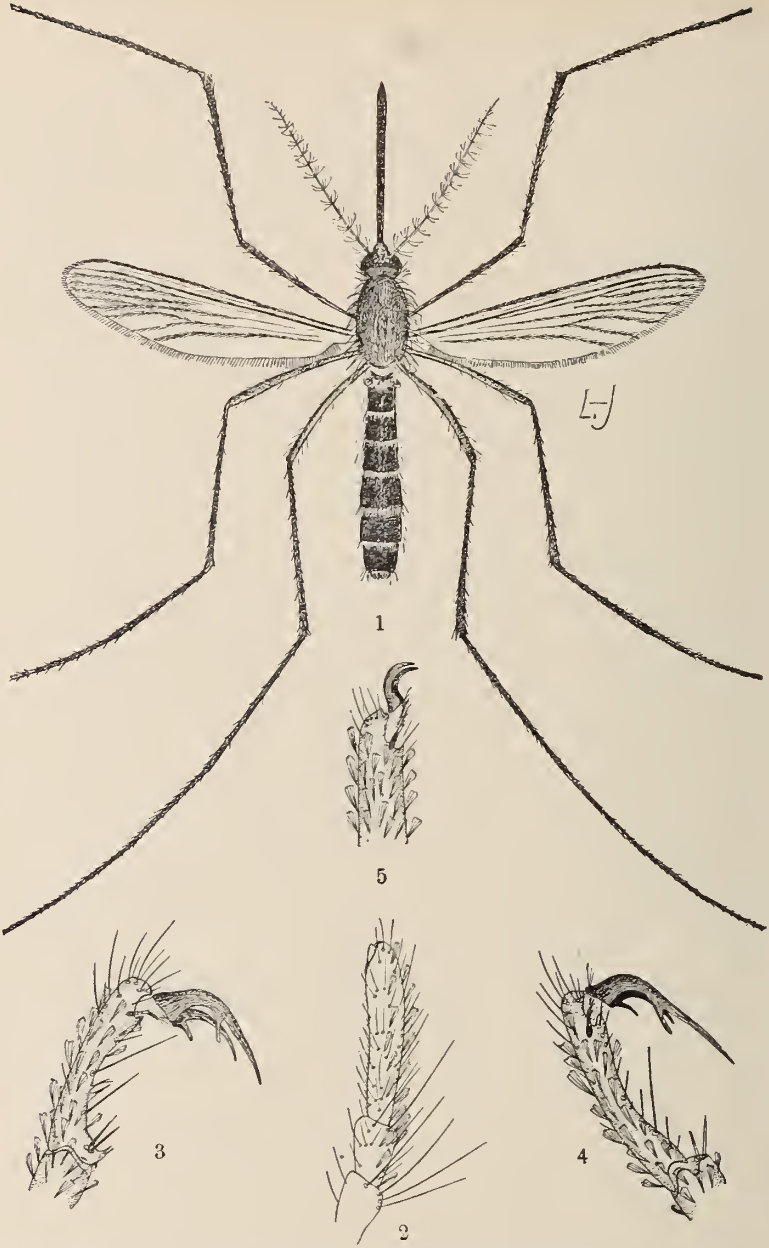


Fig. 9 Culex pipiens; 1, adult female; 2, palpus; 3, anterior; 4, middle; 5, posterior claws of male; all enlarged. (After Smith, Report of Mosquitoes of New Jersey.)

a glass jar one sees them feeding in the mud and debris at the bottom They may feed on the cast larva skins, small leaves, etc. The larvæ can be found almost anywhere, but especially in stagnant water about human habitation. Excessive foulness of water does not deter their development. Culex pipiens begins to breed in the early spring and continues its activities up to the early fall in Maryland."

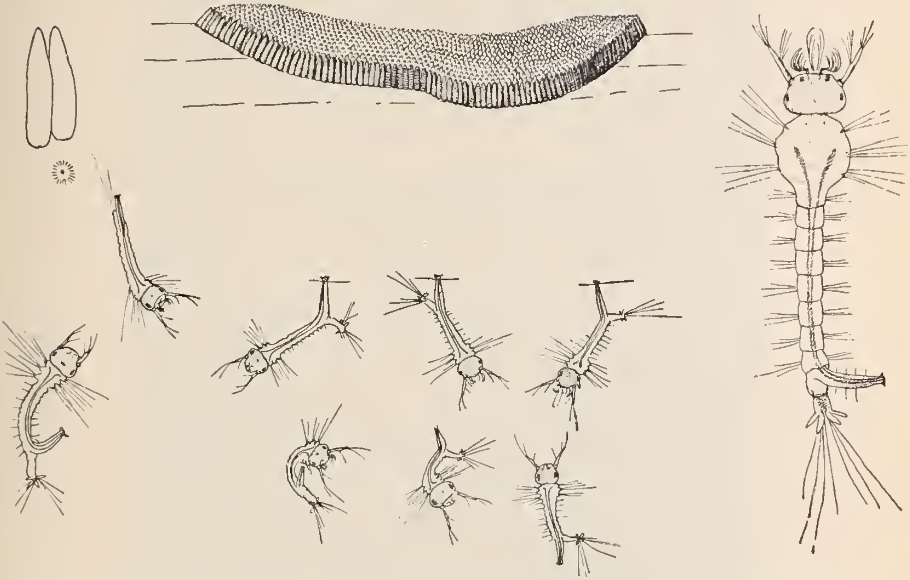


Fig. 10 Culex pipiens, egg mass, with enlarged eggs at left and young larvæ below, enlarged. After Howard, Bulletin 25, New Series, Bureau Entomology, United States Department Agriculture.

Means of Control

From the preceding discussion it is seen that the house mosquito can only breed where there is available water standing for a week or more. The water may be located in any conceivable place, in old tins, rain barrels, buckets, tubs, eave-troughs, cess pools, sewers, cisterns, or in fact anything within or without and around the home. As water is necessary to four stages of the insect's life the doing away with such stagnant water in vessels around the home is the most practical and, in fact, the only real means of preventing their breeding. The use of kerosene upon such bodies of water will serve as temporary relief by killing all larvæ or pupæ that are present when applied, but at the first rain the film of oil is likely to be washed away, and breeding may again be continued. In the case of cess pools, fire buckets or such receptacles that are not subject to influence of natural conditions the use of kerosene can be employed without much trouble provided such treatment is repeated from time to time. However, such places should be made inaccessible to mosquitoes. Briefly, the solution of the mosquito prob-

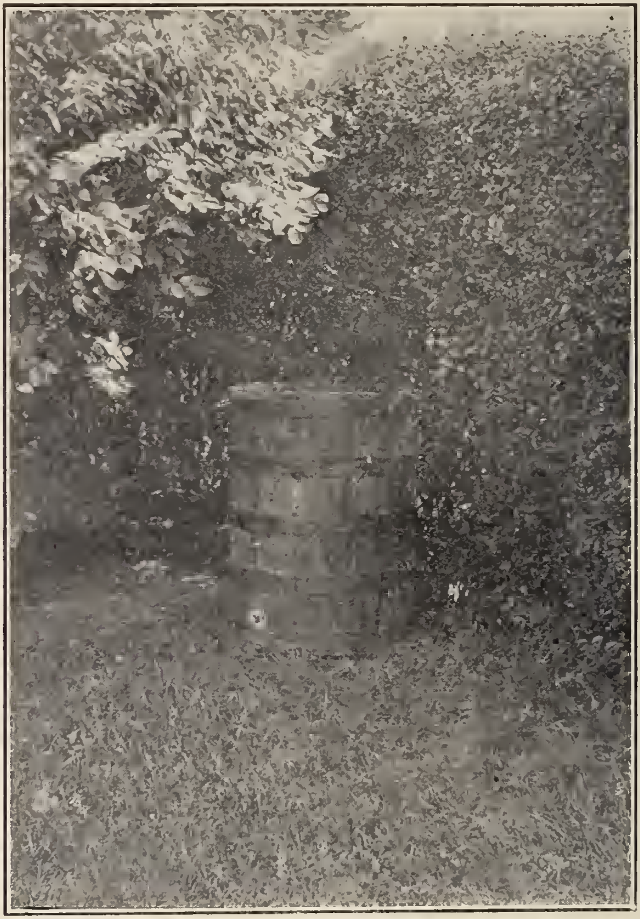


Fig. 11 Neglected barrel beneath hedge furnishing breeding place for thousands of mosquitoes. Photograph by A. B. Gahan.

lem lies in simply doing away with their breeding places by drainage or otherwise and killing by fumigation or other means all overwintering adults that may be seen in cellars, attics or other places. In city, town or village it is incumbent upon the members of the Board of Health to see that no breeding places of the pest exist in the community. In fact, where feasible, regulations should be made designating such places as nuisances to be abated as such.

In conclusion let one and all strive to keep his or her own place free from such harbors or breeding places of this most common pest and it will be seen that such coöperative effort will mean much in the diminution of the presence of the insect.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 135 MAY, 1909

BUTTER MAKING IN MARYLAND

BY C. W. MELICK

INTRODUCTION

There are 46,000 farms in Maryland and over three-fourths of them keep cows. These farms are stocked with nearly 150,000 cows, or an average of nearly four cows per farm. There are over 3000 farms which are classified as dairy farms or farms on which dairying is made a specialty. On these farms there is an average of about nine cows per farm.

The statistics as to the various products of the cows and their distribution are given in the table on the next page.

From these figures we see that the value of the dairy products of this State is over five and one-quarter millions of dollars annually and, large as this sum may seem, a little calculation will show that the average income is less than $40 per cow or, in reality, less than sufficient to feed a cow if the feed was charged at market prices.

These figures indicate that the average yield of milk is about 430 gallons or 3600 pounds of milk per cow per year. If this milk would test 4 per cent butter fat it would make the yield per cow equivalent to only about 170 pounds of butter per year. It is generally estimated that a profitable cow should yield at least 300 pounds of butter per year.

MARYLAND CREAMERIES

There are nearly 80 creameries or butter factories in Maryland. Some of these dispose of all their product as butter while others dispose of a portion of it at some seasons as cream or ice-cream.

Dairy Products of Farms in Maryland

COUNTIES	NUMBER OF FARMS REPORTING DAIRY PRODUCTS	VALUE OF ALL DAIRY PRODUCTS	VALUE OF DAIRY PRODUCTS CONSUMED ON FARMS	MILK		CREAM	BUTTER		COTTAGE CHEESE	
				Gallons produced	Gallons sold	Gallons sold	Pounds made	Pounds sold	Pounds made	Pounds sold
The State......	36,009	$5,228,698	$1,709,854	64,040,517	20,654,446	135,169	9,096,662	5,828,684	338,453	328,577
Allegany......	806	113,577	50,902	1,013,108	200,219	2,060	183,300	104,856	1,352	1,275
Anne Arundel.	1,161	118,781	74,798	973,188	170,924	707	152,593	45,729	2,192	2,028
Baltimore.....	3,641	1,103,039	187,615	10,370,504	5,295,885	20,543	1,075,274	731,099	318,454	314,766
Baltimore City.	86	108,092	5,901	605,770	515,412	2,390	12,190	4,584	....	....
Calvert........	900	50,042	45,663	480,375	11,850	68	35,775	10,631	212	135
Caroline.......	1,331	88,883	53,178	1,351,051	135,502	122	260,683	124,074	21	....
Carroll........	3,007	527,957	99,800	7,690,576	2,561,193	5,464	1,258,700	1,047,330	20	....
Cecil..........	1,477	241,230	64,737	3,641,622	1,451,044	487	484,790	339,203	....	....
Charles........	1,474	70,487	62,584	812,086	21,247	....	133,555	25,510	....	....
Dorchester....	1,391	79,744	48,777	1,159,085	223,552	41	158,372	66,810	....	....
Frederick......	3,330	525,672	120,887	8,745,300	2,268,780	51,610	1,493,740	1,146,740	3,050	2,400
Garrett........	1,637	172,702	95,640	2,176,704	197,152	1,091	420,883	256,237	102	101
Harford.......	1,622	426,960	91,524	5,268,218	2,681,651	576	566,243	338,471	....	....
Howard.......	1,071	171,077	54,988	2,276,540	361,298	9,598	459,873	336,786	....	....
Kent..........	797	105,019	31,665	1,800,378	884,450	505	136,027	82,466	....	....
Montgomery...	1,768	450,230	102,101	4,214,832	2,085,241	21,010	320,835	247,944	1,607	1,583
Prince George.	1,532	188,488	98,030	1,674,568	415,749	707	215,393	74,922	51	....
Queen Anne....	1,202	89,568	50,169	1,549,988	369,736	645	173,545	75,265	....	....
St. Mary......	1,070	54,503	49,934	622 063	4,042	12	107,538	19,208	105	....
Somerset......	856	51,051	36,422	580,653	43,472	10	111,714	39,093	185	....
Talbot........	985	86,346	47,416	1,333,438	312,595	....	172,370	71,973	561	505
Washington....	2,073	231,131	97,581	3,733,544	394,499	17,440	793,073	508,775	9,844	5,289
Wicomico.....	1,389	79,273	60,117	963,856	27,945	83	187,881	73,640	54	....
Worcester.....	1,403	94,846	79,425	1,003,070	21,008	....	182,315	57,338	643	495

The creamery industry of this State is probably not as large as it was ten years ago and it has not been as successful as it should have been, consequently it has not made the growth which circumstances would seem to have warranted.

Some creameries have been discontinued because of the extension of the area for the shipment of milk and cream which has proved more profitable than butter, but there still remains many sections of the State which seem to offer an opportunity for the creamery industry and which no doubt would have been developed had more encouragement been received from the reports of those sections where creameries were operating.

There are a few sections where creameries have been abandoned because of insufficient support but in most cases the support would have been forthcoming had they proved of greater financial benefit to their patrons.

Many of the creameries were not properly planned and equipped and many paid too much for the equipment they had. Most of the creameries in this State have failed to recognize that the operator or buttermaker should be a person skilled and trained in the work. The attempt to use untrained buttermakers has resulted in the turning out of a product deficient in quality and uniformity and consequently has not brought the creamery or its patrons the profits which they should have had or which were expected.

Many creameries produce at times as good butter as any market demands and some creameries always produce a good quality of butter, but in both cases they fail to turn out a uniform product. In order to establish a reputation and a good market for its products a creamery cannot be too particular or lay too much stress on having its butter uniform. A uniform product should look, smell and taste the same every week in the year. With a good and uniform product a good market can be established. A trade cannot be held with a product lacking uniformity, even though the individual shipments or week's output is of good quality.

The prevailing fault of Maryland creameries is a lack of uniformity. Many of them produce a high quality of butter, but it is too variable to establish a brand and hold a definite trade.

INVESTIGATIONS CONDUCTED

In order to determine some of the causes for lack of uniformity of butter made at Maryland creameries, this Station conducted some investigations at a few representative creameries in five different counties of the State. The investigations may be classified as follows:

1. An inspection and score of the patrons' herd, facilities and premises.
2. Grading the milk according to score and churning each grade of cream separately.
3. Determining the bacteria content, the acidity, and making a curd test of each patron's milk.
4. Noting the methods employed by the creameries.
5. Determining the commercial grade and value of butter derived from different qualities of milk.

CREAMERIES INVESTIGATED

The investigations were conducted at the following points:

1. "White House" Creamery located in Baltimore County 5 miles east of Hampstead.
2. Harford Creamery located in Harford County 8 miles east of White Hall.
3. Cold Spring Creamery located in Carroll County at New Windsor.
4. Sparrows Point Store Co.'s Creamery, located in Frederick County at Mt. Pleasant.
5. Easton Creamery located in Talbot County at Easton.

METHODS FOLLOWED

The plan followed was to procure a list of the patrons of each creamery and then proceed to visit each one and make an inspection of their premises, herds, and methods employed, and score the same according to the score card adopted by the Dairy Division of the U. S. Department of Agriculture.

After this data was obtained the inspector returned to the creamery to make a churning test, and to determine the bacteria content of the milk of the different patrons. The milk that received a score of 80 or above was placed in group or grade No. 1, and that under 80 in group or grade No. 2. The milk from the patrons in different groups or grades was placed in different vats. Each grade was separately churned and treated the same at each creamery, and butter from each lot submitted to several experts for judging as to its quality.

The butter was scored according to official points which for perfect butter is as follows:

Flavor	45
Texture	25
Color	15
Salt	10
Package	05
Total	100

INVESTIGATIONS AT "WHITE HOUSE" CREAMERY

The investigations were begun on February 6, 1908, at the "White House" Creamery, located five miles east of Hampstead in Baltimore County.

A list of the patrons, twenty-nine in number, was secured and the premises of each visited and scored.

After scoring the patrons' dairies their milk was graded as it was delivered at the creamery, and placed in different vats according to grade. The following represents the score of their dairies and milk, and the quantitative analysis of the bacteria present in the milk at the time of delivery. Group No. 1 represents the patrons whose milk scored 80 or above and was placed in the first grade lot. Group No. 2 represents the patrons whose milk scored below 80 and was placed in the second grade lot.

Average Detailed Score of Patrons in Groups I and II of White House Creamery

EQUIPMENT.	SCORE.		
	Perfect.	Allowed.	Allowed.
Cows		*Group I.*	*Group II.*
Health	6	2	2
Apparently in good health 1			
If tested with tuberculin once a year and no tuberculosis is found, or if tested once in six months and all reacting animals removed 5			
(If tested only once a year and reacting animals found and removed, 2.)			
Comfort	2	2	2
Bedding 1			
Temperature of stable 1			
Food (clean and wholesome)	2	1.5	1
Water	2	2	2
Clean and fresh 1			
Convenient and abundant 1			
Stables.			
Location of stable	2	1	1
Well drained 1			
Free from contaminating surroundings 1			
Construction of stable	4	1	0
Tight, sound floor and proper gutter 2			
Smooth, tight walls and ceiling .1			
Proper stall, tie, and manger ..1			
Light: Four sq. ft. of glass per cow (Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)	4	0	0

METHODS.	SCORE.		
	Perfect.	Allowed.	Allowed.
Cows.		*Group I.*	*Group II.*
Cleanliness of cows	8	5	3
Stables.			
Cleanliness of stables	6	2	1.5
Floor 2		1	.5
Walls 1		.5	.5
Ceiling and ledges 1		0	0
Mangers and partitions 1		.5	.5
Windows 1		0	0
Stable air at milking time	6	3	2
Barnyard clean and well drained	2	1	1
Removal of manure daily to field or proper pit	2	1	.5
(To 50 feet from stable, 1.)			
Milk Room.			
Cleanliness of milk soom	3	1.5	1
Utensils and Milking.			
Care and cleanliness of utensils	8	4	3
Thoroughly washed and sterilized in live steam for 30 minutes 5			
(Thoroughly washed and placed over steam jet, 4; thoroughly washed and scalded with boiling water, 3; thoroughly washed, not scalded, 2.)			
Inverted in pure air 3			
Cleanliness of milking	9	3	2
Clean, dry hands 3			
Udders washed and dried 6			
(Udders cleaned with moist cloth, 4; cleaned with dry cloth at least 15 minutes before milking, 1.)			

Ventilation: Automatic system	3	0	0
(Adjustable windows, 1.)			
Cubic feet of space for cow: 500 to 1000 feet	3	0	0
(Less than 500 feet, 2; less than 400 feet, 1; less than 300 feet, 0; over 1,000 feet, 0.)			
Utensils.			
Construction and condition of utensils	1	.5	.5
Water for cleaning	1	1	1
(Clean, convenient, and abundant.)			
Small-top milking pail	3	0	0
Facilities for hot water or steam	1	.5	0
(Should be in milk house, not in kitchen.)			
Milk cooler	1	0	0
Clean milking suits	1	0	0
Milk Room.			
Location of milk room	2	1	.5
Free from contaminating surroundings 1			
Convenient 1			
Construction of milk room	2	1	.5
Floor, walls, and ceiling 1			
Light, ventilation, screens 1			
Total	40	13.5	10.5

Handling the Milk.			
Cleanliness of attendants	1	.5	.5
Milk removed immediately from stable	2	1	1
Prompt cooling. (Cooled immediately after milking each cow))	2	0	0
Efficient cooling; below 50° F	5	2	2
(51° to 55°, 4; 56° to 60°, 2.)			
Storage; below 50° F	3	1	1
(51° to 55°, 2; 56° to 60°, 1.)			
Transportation; iced in summer	3	1	1
(For jacket or wet blanket allow 2; dry blanket or covered wagon, 1.)			
Total	60	26	19.5

Group I. Score for equipment 13.5 + Score for methods 26 = 39.5 Final Score.
Group II. Score for equipment 10.5 + Score for methods 19.5 = 30 Final Score.
NOTE 1.—If any filthy condition is found, particularly dirty utensils, the total score shall be limited to 49.
NOTE 2.—If the water is exposed to dangerous contamination or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

GROUP 1

	SCORE		
Patrons No.	*Premises*	*Milk*	*Bacteria per cc.*
1	35.5	89	600,000
2	38.0	86	1,000,000
3	38.5	85	500,000
4	40.0	84	700,000
5	41.5	86	500,000
6	38.5	91	500,000
7	41.0	81	700,000
8	38.5	91	800,000
9	41.5	85	100,000
10	40.5	93	1,000,000
11	39.0	83	800,000
12	35.5	83	400,000
13	40.5	95	620,000
14	40.5	82	1,200,000
15	44.0	95	800,000
Average	39.5	87.3	681,333

GROUP 2

Patron No.			
16	27.5	48	2,000,000
17	28.0	49	1,440,000
18	32	81	1,000,000
19	32	48	1,440,000
20	32.5	56	1,200,000
21	32	72	1,200,000
22	32	72	
23	31	61	1,000,000
24	28.5	79	1,500,000
25	28.5	74	1,800,000
26	30	76	1,200,000
27	30	67	1,100,000
28	29	59	200,000
29	27	68	600,000
Average	30	65	1,206,154

AVERAGE SCORE OF MILK

		Standard Score	*Group 1*	*Group 2*
Condition	Cleanliness	15	12.3	10
	Bacteria per cc.		681,333	1,206,154
	Acidity	10	9	5
Flavor	Taste	25	22	15
	Smell	25	23	18
	Curd test	25	21	13
		100	87.3	61

On February 21 the milk from both groups was again scored as it arrived at the creamery, and after separating, the cream from each was ripened at 70° F., until 6 o'clock in the evening. It was then allowed to cool down to 60° F., and by the following morning had reached a temperature of 48°F.

Each churning was made under identical conditions as follows:

There was no pasteurizer at this creamery and no starter was used in ripening the cream.

The acidity of the cream when churned was 6 per cent, the temperature was 56° F., the churn was about one-third full each time, the butter granules were about the size of wheat grains, and the butter was washed twice with water at 50° F.

	1st Grade Cream	*2d Grade Cream*
Pounds of cream	300	250.
Per cent fat in cream	21	18
Pounds of butter fat	63	45
Grade of cream	94	75
Temperature of creamery	44°F.	42°F.
Amount of vegetable color used	35cc.	27 cc.
Time required to churn	18 min.	40 min.
Temperature of butter	50°F.	48° F.
Temperature of buttermilk	48°F.	47°F.
Acidity of buttermilk	.82	.83
Amount of salt used	6 lb.	4 lb.
Amount of salt used per lb. butter	1.28 oz.	1.29 oz.
Per cent of fat in buttermilk	.2	.25
Pounds of fat lost in manufacture	.469	.45
Per cent of fat lost in manufacture	.74	1.01
Pounds of butter made	75.5	50
Per cent overrun	19.8	11.1
Per cent moisture	16	15

SCORE OF BUTTER WHEN MADE

	Perfect Score	*Group 1 Cream*	*Group 2 Cream*	*Mixed Cream*
Flavor	45	37	34	34.5
Texture	25	24	24	23.5
Color	15	15	15	15
Salt	10	10	10	10
Package	5	5	5	5
	100	91	88	88

Samples of butter (from the first and second grade cream) together with samples of butter from the mixed cream of the creameries' average make, were numbered and sent to the following places for scoring: The Dairy Division of the U. S. Department of Agriculture; M. M. Rouzer, Butter Expert of the Central Market, and Geo. F. Oyster, butter and egg commissioner of Washington, D. C., and S. S. Edel's Sons, and Robins & Co., butter commissioners of Baltimore.

	No. 1	*No. 2*	*No. 3*
Experiment Station Official	91	88	88
Government Expert	92	89	89
Central Market, Washington	89	85	86
Butter Commissioner, Washington	93	86	87
Butter Commissioners, Baltimore	91	84	84
Butter Commissioners Baltimore	94	90	87
	91.6	87	86.8

REMARKS

Government Expert, B. D. White: "Good butter for this time of the year. Wintry, cowstable flavor."

Central Market, M. M. Rouzer: "There is from three to five cents difference in that butter on this market."

S. S. Edel's Sons: "We find these samples good winter butter. No. 2 is sour and on the turn to rancid. In regard to difference in present prices on the market we assume that sample No. 1 would pass as extra, bringing top price. Samples 2 and 3 as firsts about three cents less.

The Baltimore and Washington Markets on the days in which the scoring was done, February 24 and 25, quoted butter as follows:

	Washington	*Baltimore*
Extras	33½ to 34½	33 to 34
Firsts	31 to 33	29 to 32
Seconds	26 to 27	26 to 27

Butter scoring above 90 per cent is classed as extras, from 80 to 90 as firsts and below 80 as seconds.

According to the score of B. D. White (the government expert who is considered one of the best butter judges in America) and G. F. Oyster, the butter made from the cream from group 1 would be classed as extras, and that from group 2 as firsts, making a difference of from 4½ to 7½ cents a pound in the Washington market and from 1 to 5 cents a pound in the Baltimore market. According to Mr. Rouzer they would be classed as firsts and seconds, making a difference of from 4 to 7 cents a pound on the Washington market in which he works.

INVESTIGATIONS AT THE HARFORD CREAMERY

On March 12 the work was taken up at the Harford Creamery, located in Harford County, eight miles east of White Hall, Md.

The premises of the patrons were scored, the milk graded at the creamery, and butter made from the two grades of cream as in the previous experiment.

At this creamery the milk was pasteurized and the cream ripened with starter made from commercial culture. This must be borne in mind in comparing the reports of the judges with those of previous experiments, for it is generally conceded that such treatment of the cream materially lessens the difference which would ordinarily occur between the number one and two grades.

The score of the patrons premises and grade of the milk were as follows:

GROUP 1.

Patron's No.	*Average Premises*	*Score of Milk*	*No. Bacteria per cc.*
1	34	74.2	325,000
2	41	87	300,000
5	40	85	290,000
6	40.5	87.7	600,000
9	42	82	160,000
15	31.5	82.5	270,000
16	43	89	700,000
32	34.5	78	1,900,000
34	32	88	1,000,000
35	31.5	81	900,000
36	44	87	250,000
42	40	86	420,000
Average	37.83	83.95	592,916

GROUP 2

Patron's No.	*Average Premises*	*Score of Milk*	*No. Bacteria per cc.*
3	33.5	84	400,000
7	37	65	1,050,000
8	28.5	62	1,500,000
10	32.5	80	700,000
11	34	71.5	190,000
12	30.5	65	950,000
13	40	65	410,000
14	41	74	190,000
17	36	70	310,000
18	23	73	620,000
19	32	65	160,000
20	32	72	400,000

GROUP 2—Continued

Patron's No.	*Average Premises*	*Score of Milk*	*No. Bacteria per cc.*
21	44	63	520,000
24	31	69	480,000
25	35	79	530,000
26	32	85	480,000
27	27	70	800,000
28	34	70	680,000
29	37	79	750,000
31	28	68	910,000
33	33	77	740,000
37	30.5	71	970,000
38	31	74	1,100,000
39	32.5	78	1,000,000
40	34	70	600,000
41	27	76	620,000
Average	32.88	72.13	656,154

Average score of milk and dairies.

GROUP 1			GROUP 2		
Milk		*Dairy*	*Milk*		*Dairy*
Condition:			*Condition:*		
Cleanliness 13.			Cleanliness 11.		
Bacteria per cc. 592,916			Bacteria per cc. 656,157		
Acid .29	8		Acid .38	6	
Flavor			*Flavor*		
Taste	21.4		Taste	18	
Smell	22.4		Smell	20	
Curd test	20		Curd test	17.5	
	84.8	72		72.5	70

In grading the milk on March 22 the samples of patron 19 tasted watery. An analysis was therefore made on March 24 and 26 which showed 30.12 per cent and 35.53 per cent of water adulterations respectively.

When the milk from any patron scored below 80 it was placed in number two vat regardless of home conditions. It was evident from this scoring that some of the patrons, although having inferior equipment, were careful and comparatively clean in their methods of handling the milk.

The cream was all pasteurized and ripened with and without starter for comparison.

Every batch of cream was ripened at 70° F., and churned at 55° F. The butter was washed once with one-fourth of churn full of water at 50° F. A hand churn was used for churning number 3 on March 26.

The report of the churnings is given in the following table:

	MARCH 22	MARCH 24		MARCH 26		
	Mixed Cream	1st Grade	2nd Grade	1st Grade	2nd Grade	3rd Grade
Pounds of cream	850	680	319.2	123	700	25
Per cent fat in cream	30	20	23	31	18	18
Pounds of butter fat	255	136	73.41	38.13	126	4.5
Per cent acid in cream	.6	.54	.59	.41	.71	.69
Per cent starter added	5	5	5	10	20	73
Grade of cream before adding starter	87	98	78	98	73	73
Grade of cream after ripening	91	98	90	98	88	80
Temperature of creamery	48	50	54	42	42	42
Amount vegetable color used	5.5 oz.	4 oz.	1.5	1.25	33.25	.25
Churn how full	$\frac{3}{5}$	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{1}{8}$	$\frac{1}{3}$	$\frac{1}{3}$
Time required to churn, min.	30	10	12	25	20	20
Temperature of butter	55	55	56	55	55	55
Temperature of buttermilk	54	55	56	54	54	54
Acidity of buttermilk	.7	.68	.74	.61	.77	.7
Amount of salt used	17 lb.	15 lb.	5 lb.	4 lb.	12 lb.	½ lb.
Amount of salt used per pound butter	.97 oz.	1.6 oz	1.1	1.5 oz.	1.45 oz.	1.8 oz.
Per cent fat in buttermilk	.3	.25	.3	.2	.28	.25
Pounds fat lost in manufacture	1.7	1.31	1.72	.15	1.58	.05
Per cent fat lost in manufacture	.66	.96	2.34	.52	.22	1.10
Pounds butter made	281	152.5	77	45	135.5	4.5
Per cent overrun	10.19	12.28	4.86	18.01	7.54	0
Per cent moisture in butter (per cent)	14.28	16.66	14.0	15	14	16

Samples of the butter from these churnings were numbered as follows and sent to various judges.

The churning of March 22, numbers 5 and 55 contained the entire batch of mixed cream from all patrons, and 5 per cent of starter was added. Numbers 1 and 11 were samples from No. 1 cream on March 24, to which 5 per cent of starter was added. Numbers 2 and 12 were from No 2 cream of the same date which also contained 5 per cent of starter. Numbers 13 and 15 were from No. 1 cream, March 26, containing 10 per cent of starter, and numbers 22 and 24 were from No. 2 cream on that date and containing 20 per cent of starter. Numbers 3 and 33 were samples from the same cream as those of 22 and 24, No. 2 cream, but to which no starter was added.

Results of Scoring.

Number	5	55	1	11	2	12	13	15	22	24	3	33
Experiment Station Official	92		94		90		94		91		86	
Gov't Expt., B. D. White	92	91.5	93.5	93	91	91.5	93	93	92.5	92	86	86
S. K. Keller, K St., Market, Washington, D. C	90	90	91	92	91	90	93	94	92	92	85	85
Rudurd & Co., Central Market, Washington, D. C.	91	92	92	92	90	90.5	94	93	92	93	80	80
Edel's Sons, Baltimore	83	85	88	88	75	80	95	94	85	90	71	73
Robins & Co., Baltimore	85	91	88	88	86	88	90	91.5	92.5	93	83	85
Average	88.8	90.3	91.1	91.1	87.1	88.3	93.3	93.3	90.8	91.8	81.8	82.5

REMARKS

Experiment Station Official: "Numbers 13 and 15 had a clean, nutty flavor, numbers 1 and 11 had a mild flavor. All others had an unclean flavor which was more pronounced in numbers 3 and 33."

Government Expert: "It is all fair butter except 3 and 33 which has a musty, unclean flavor."

K Street Market, Washington: "It would all pass as firsts on this market except numbers 3 and 33. They would be classed as seconds."

Central Market, Washington: "All firsts except 3 and 33. They are thirds."

Edel's Sons, Baltimore: "Numbers 2, 12, 3, 33, 5, and 55 are rancid."

Robins & Co., Baltimore: "The majority of the samples were a little light in color and salt for this market."

INVESTIGATIONS AT COLD SPRING CREAMERY

The investigations were resumed on April 13 at the Cold Spring creamery, of New Windsor, Md. The experiments of the two previous creameries were repeated. Among the forty-two patrons of the New

Windsor creamery there were only eight who delivered milk. The remaining thirty-four used hand separators and delivered cream.

No pasteurizer or starter was used at this creamery but the cream and milk was graded regularly and the butter made from each was sold for different prices according to quality.

The score of the dairies, and milk and cream of the patrons is given in the following table:

	AVERAGE SCORE OF GROUP 1		
Patron No.	*Premises*	*Milk*	*No. Bacteria per cc.*
1	34.5	85	250,000
4	39	93	160,000
22	43.5	93.8	50,000
19	37.5	93	50,000
7	36.5	88.6	200,000
12	38.5	91	120,000
14	38.5	91	50,000
5	38.5	90	30,000
10	37	84	100,000
12	39.5	81	350,000
35	37	72.5	200,000
33	38.5	92	190,000
24	33.5	93.5	250,000
2	38.5	92.9	300,000
Average	37.9	88.6	164,286

Patrons having part of cream in Group 1 and part in Group 2.

No.	*Premises*	*Milk*	*Bacteria per cc.*
8	41	87	200,000
81	35.5	78	100,000
6	35	71	120,000
11	36.5	80	100 000
29	41.5	85	500,000
32	32.5	77	100,000
20	32	81	400,000
21	34	79	250,000
34	34.5	83	250,000
60	33	79	500,000
9	35	73	450,000
62	32	75.5	300,000
18	35	79	950,000
17	33	77.5	200,000
23	35	80	600,000
13	36	82.5	500,000
Average	35	79.2	345,000

SCORE OF GROUP 2

	Premises	*Milk*	*No. Bacteria per cc.*
3	30	72	600,000
36	37	75.5	130,000
27	25.5	77	200,000
16	30.5	67	950,000
60	32.5	68	600,000
34	38	78.4	550,000
64	33	75	450,000
Average	32.2	73.2	497,143

SCORE OF GROUP 3—GARLIC FLAVOR

Patron No.	*Premises*	*Milk*	*No. Bacteria*
61	27.5	70.3	300,000
63	32.0	81.4	150,000
26	31.0	73.8	300,000

AVERAGE SCORE OF MILK AND DAIRIES

Conditions:	*Group 1*	*Group 1 and 2*	*Group 2*
Cleanliness	13.5	12.5	11.7
Bacteria per cc	164,286	345,000	497,143
Acidity	8.1	6	6
Flavor:			
Taste	22	19.5	18
Smell	23	23.2	19.5
Curd test	22	18.0	18
Milk, total	88.6	79.2	73.2
Dairy	37.9	35.0	31.7

The cream was ripened after the usual methods employed at this creamery without the use of pasteurizer or starter. A temperature of 70° F., however, was maintained in ripening each batch. Garlic tainted cream was placed in a separate vat as third grade. The butter made at this creamery was all washed once, according to the existing custom, and with water at 55° F. The report of the churnings thus made is as follows:

	APRIL 18		APRIL 25		
	1st Grade	*2nd Grade*	*1st Grade*	*2nd Grade*	*3rd Grade*
Pounds of cream	814	1200	1200	825	560
Per cent of fat in cream	29	25	26.5	25	25
Per cent acid in cream	.5	.55	.5	.6	.6
Pounds of butter fat	236	300	318	206	140
Grade of cream before ripening	97	75	98	70	50
Grade of cream after ripening	96.5	76	98	70	50
Temperature when churned	55	56	54	53	54
Temperature of creamery	52	48	60	65	60
Amount Vegetable color used	2 oz.	3.5 oz.	3.5 oz.	2 oz.	1¼ oz.
Churn, how full	½	¾	¾	½	⅓
Time required to churn	20	30	30	20	19
Temperature of butter	54	55	60	61	60
Temperature of buttermilk	58	57	62	64	62
Acidity of buttermilk	.8	.9	.85	.9	.83
Amount of salt used	15 lb.	18 lb.	19.5	12 lb.	8 lb.
Per cent of fat in buttermilk	.3	.7	.2	.8	.6
Lbs. fat lost in manufacture	1.6	5.24	1.64	4.84	.66
Per cent fat lost in manufacture	.07	1.74	.51	2.35	.47
Pounds butter made	280.5	336.5	380	220	450
Per cent over run	19	12.1	19.5	6.8	7.14
Per cent of moisture	13	12	14	14.9	20
Score of butter when made:					
Scored by Experimental Station official	92	90	92	88	

The butter made on April 18 was numbered 1, 11, 2, 12; numbers 1 and 11 being churned from 1st grade cream, and 2 and 12 from 2nd grade cream. The butter made on April 25 was numbered as follows: From 1st grade cream 3 and 13, from 2nd grade cream 4 and 14, and from 3rd grade cream, 33 and 35. Samples of each were sent to various commission merchants in Washington and Baltimore and the Dairy Division of the United States Department of Agriculture, and the following reports thus secured. Samples were sent to two firms in Baltimore but in one instance the samples were mislaid and the report from that firm could not be included.

	1	11	2	12	3	13	4	14	33	35
Government Expert, B. B. White, Washington, D. C.: "With the exception of Nos. 33 and 35 it is all very good for this time of the year. Those samples I reject on account of garlic flavors"	90	91	90	90	91	91	88	87	0	0
H. C. Coburn, Central Market, Washington, D. C.	92	93	89	91	94	92	89	87	0	0
M. M. Rouzer, Central Market, Washington, D.C.: "Nos 1, 11, 3 and 13 are firsts. 2, 12, 4 and 14 are seconds and 33 and 35 are a low grade. I could not use them in this market"	89	90	85	86	90	91	87	85	0	0
Robins & Co., Baltimore, Md.: "Nos. 33 and 35 are so badly tainted with garlic that it has no grading on this market. Buyers are scarce and hard to find for such goods"..	92	93	92	93	96	96	90	91	0	0
Average..................	90.7	91.7	91	90	92.7	92.6	88.5	87.5		

As will be seen from this table there was only a slight difference in the butter made from first and second grade cream. This was due to the fact that the cows of these patrons were milked for the most part in open yards and there was an absence of stable flavors in their milk. The defects of the second grade cream consisted of unclean and grass flavors. These were not as detrimental as the stable manure flavor found in the previous investigations during the months when cows were kept in the stables the greater part of the time.

According to Mr. Robins of Baltimore the butter made from first and second grade cream would all be classed as extras. According to Washington judges the butter from 2nd grade cream made on April 25 would be classed as firsts, worth from one to two cents less per pound than that of 1st grade of the same date and 1st and 2nd grade of April 18.

The price of butter on the two markets in question on April 30 when the scoring was done was as follows:

	Extras	*Firsts*	*Seconds*	*Thirds*
Baltimore	30 to 31	29 to 30	27½ to 28	19 to 20
Washington............	30½ to 31½	29½ to 30½	28 to 29	21 to 22

Nos. 33 and 35, the butter from garlic tainted cream, was rejected in every instance, the garlic taint appearing even stronger in the butter than it was in the cream.

In this as in previous investigations the per cent of overrun was much larger in the churnings made from first than from second grade cream regardless of the fact that small churnings generally yield a higher per cent of overrun than large churnings.

The difference in value of the overrun is discussed later in this bulletin, pages 249 and 266.

INVESTIGATIONS AT THE SPARROWS POINT STORE COMPANY'S CREAMERY

The work was discontinued April 30 for the remainder of the season when the cows were kept on pasture and in open fields. Under such circumstances a more uniform condition naturally exists.

Investigations were resumed January 6, 1909, at the Sparrows Point Store Company's creamery at Mt. Pleasant, Frederick County, Md. A pasteurizer but no starter was used in this creamery. The butter was all being sold at the Company's store at Sparrows Point, Md. The patrons' barns all lacked light and ventilation, and were very similar to those of Carroll, Baltimore and Harford Counties, where the work was previously carried on. The barns usually served as combined horse and cow barns, and frequently possessed a loose ceiling or haymow floor where chaff sifted through. The manure piles were invariably too near the barn door, and some of the patrons milked with wet hands.

Very little first grade milk being produced at this creamery, only second and third grade churnings were made, and the patrons were accordingly divided into groups 2 and 3.

The score of the patrons' dairies and their milk was as follows:

GROUP NO. 2

Patron's No.	SCORE *Premises*	 *Milk*	*No. Bacteria per cc.*
2	37	70	200,000
3	37	85	100,000
4	46.5	72.4	250,000
11	37.5	71.4	250,000
13	37	74.8	290,000
14	45.5	74.4	300,000
15	37.5	71.4	310,000
17	46.5	70.8	180,000
18	39.0	80	300,000
19	42	77	500,000
20	37	71	225,000
25	37	70.2	400,000
30	44	75.2	400,000
31	43	73	300,000
Average	40.46	74.04	283,214

GROUP NO. 3

Patron's No.	SCORE *Premises*	*Milk*	*Bacteria per cc.*
5	33	65	400,000
6	41	66.4	400,000
7	37	63.8	410,000
8	37	67.6	300,000
9	37.5	52	600,000
10	35	69.2	1,200,000
12	41	65.2	1,250,000
16	41	69.4	380,000
22	35	50.6	1,150,000
23	38	68.4	600,000
24	35.5	58	800,000
26	41.5	43.6	460,000
27	37	60	1,000,000
29	37.5	54.8	520,000
Average	37.64	61	676,427

The factory churn being too large to churn less than the entire amount of cream from the milk received at this season of the year, a hand churn was used in these investigations. The results compared favorably with those obtained by use of the factory churn when the entire amount of mixed cream was churned, and the latter are therefore used in the following table.

The cream was all ripened at 65° F. at this creamery, churned at .6 % acidity, the churn was about one-third full each time, the butter was washed twice with water at 55° F., and one ounce of salt was added per pound of butter.

The following churning reports illustrate the differences in the butter made from the different grades of cream.

	JANUARY 14, 1909		JANUARY 15
	2d Grade Cream	*3d Grade Cream*	*Mixed 2d and 3d Grade*
Pounds cream	24	24	256
Per cent fat in cream	24	23	26.5
Pounds butter fat	5.76	5.52	67.84
Grade of cream, score	89	75	80
Temperature when churned	60°F.	60°F.	56
Temperature of creamery	46°F.	46°F.	50
Amount of coloring used	¼ oz.	¼ oz.	3 oz.
Time required to churn	35 min.	35 min.	35°F.
Temperature of butter	60°F.	60°F.	60°F.
Temperature of buttermilk	60°F.	60°F.	61°F.
Acidity of buttermilk	.84	.86	.88
Amount of salt used	8.75 oz.	7.75	4.4
Per cent fat in buttermilk	.22	.27	.1
Pounds fat lost in manufacture	.03	.04	17
Per cent fat lost in manufacture	.5	.72	.25
Pounds butter made	7	6.2	81
Per cent overrun	22.8	12.3	19.5
Per cent moisture in butter	11.85	10.8	16
Score of butter when made	93	90	91.5
Score of butter by U. S. Dairy Division	93	90	92
Score of butter by Washington Dairy Co	90	80	88
Score of butter by H. W. Shammell	90	82	87
Score of butter by Edel Sons	90	88	89
Average score after reaching the market	90.7	85	89

REMARKS

Dairy Division, Prof. Thompson: "This is fair butter for this time of the year, especially the samples scoring 93. The others have more of an unclean flavor."

Washington Dairy Company: "Part of that would go as firsts and part as seconds on this market. None of it would go in the extra or Elgin class."

Mr. H. W. Shammel: "I would call that firsts and seconds, but would not care to handle any of it."

Edel Sons: "As a whole a very poor lot of butter."

The price of butter on the markets at this time was as follows:

	Baltimore	*Washington*
Extra Creamery	.33 to 34	34 to 35
Firsts	.31 to 32	32 to 33
Seconds	.25 to 26	26 to 27

INVESTIGATIONS AT EASTON CREAMERY

On January 25 the work was taken up at the Easton creamery of Easton, Maryland.

There was no pasteurizer, starter, or even a Babcock tester used in this creamery. The amount of color and salt used in the butter was added according to guess. Milk was paid for by the hundred pounds.

One patron had only pure bred Jerseys, two patrons had only pure bred Holsteins and the others had grade cattle. Several of them watered their milk. All received the same price per hundred for their product.

Many of the patrons had open dairy barns and consequently received a higher score on the points of light and ventilation. The roofs were generally of loose straw, however, and this practically overcame the good effects of such a system. The following represents the score of their dairies and milk. Very little first grade milk being produced it was graded into seconds and thirds, the patrons being grouped accordingly.

GROUP 2

Patron's No.	SCORE		Bacteria per cc.
	Premises	Milk	
1	46.5	74.6	290,000
3	41.5	79.4	375,000
4	54.5	64.0	380,000
5	50.5	78.2	300,000
8	36	67	350,000
9	57	55	1,290,000
11	59.5	78	400,000
13	47.0	79	890,000
14	44.5	69	400,000
15	53.0	88.6	260,000
16	58.0	81.8	310,000
18	56.5	50.0	1,200,000
Average	50.37	72.05	528,750

GROUP 3

Patron's No.	SCORE		Bacteria per cc.
	Premises	Milk	
2	37	32.8	900,000
6	42.5	29.8	1,430,000
7	45	66.0	970,000
10	52.5	63.6	720,000
12	41.5	35	700,000
17	30	9	1,520,000
19	36	47.4	960,000
20	39.5	42.0	1,200,000
Average	45.5	40.7	1,050,000

At this creamery also the factory churn was too large to churn less than the entire amount of cream from the milk received at this time of the year. A hand churn was therefore employed in these investigations and the results compared with those of the average factory churnings.

The cream was all ripened at 60° F. at this creamery, churned at 60° F., one-fourth ounce of coloring was used in each churning, twenty minutes were required to churn each, the temperature of the butter and that of the buttermilk was 60° F., and two washings were given with water at 54° F.

CHURNINGS MADE FROM THE DIFFERENT GRADES OF CREAM

	JANUARY 27, 1909		
	2nd Grade Cream	*3rd Grade Cream*	*Mixed Cream*
Pounds cream	15	15	15
Per cent fat in cream	41	36	38
Pounds butter fat	6.15	5.4	5.7
Per cent acid in cream	.4	.45	.49
Grade of cream, score	88	.70	75
Acidity of buttermilk	.7	.58	.65
Amount of salt used	8.4 oz.	6 oz.	6½ oz.
Per cent fat in buttermilk	1	1.5	1
Pounds fat lost in manufacture	.08	.15	.1
Per cent fat lost in manufacture	1.3	2.77	1.75
Pounds butter made	6.75	4.75	5
Per cent overrun	9.75	0	0
Per cent moisture in butter	10	12	11
Score of butter when made	86	87	84
Score of butter by U. S. Dairy Division	86	88	84
Score of butter by Washington Dairy Co	83	85	75
Score of butter by H. H. Butler	84	86	74
Score of butter by Edel Sons	85	87	78
Average score after reaching the market,	84.5	86.5	77.7

REMARKS

Dairy Division, B. D. White: "This is a very poor lot of butter. Nos. 2 and 12 are somewhat better in flavor, but it is all wintry and unclean.

Washington Dairy Company: "A low grade of butter although there is some difference in it."

H. H. Butler: "It is all poor, but there is a big difference between the samples I called firsts and seconds."

Edel Sons: "Very poor butter, but a difference of about nine points between the poorest and the other."

Price of butter at this time:

	Baltimore	*Washington*
Extra Creamery	30 to 30½	30½ to 31
Firsts	25 to 29	28 to 30
Seconds	23 to 24	24 to 25

A COMPARISON OF SOME OF THE FACTORS WHICH INFLUENCED THE QUALITY OF THE BUTTER IN THESE INVESTIGATIONS

The White House creamery produces in the winter an average of 600 pounds of butter per week. Fourteen of the patrons of this creamery were supplying milk of such poor quality that it reduced the price which the butter should bring from one to seven cents a pound. This was a loss to that creamery and to the patrons of from $6 to $42 per week, all because fourteen of its patrons delivered milk which could not be graded as No. 1. That is, when thc cream from all the patrons was mixed, the butter produced therefrom generally scored as low as that of Group No. 2 churned separately. For instead of the cream from No. 1 overcoming the defects of No. 2, the cream from the latter being allowed to ripen as it is without pasteurization or the addition of starter, contaminates the cream of Group 1. This was also proved by repeated scoring of the butter from the entire batch of cream during the preliminary part of the experiment. The butter thus made gave an average score of 88.

This low average is probably partially due to methods employed by the buttermaker who was a comparatively new man at the work. The butter made during the experiment was under the supervision of the Experiment Station representative from the time the milk was received at the creamery until the butter was printed.

Pasteurization and the use of starter evidently corrected to a great extent the poor quality of the number two cream at the Harford creamery, for the butter made therefrom in the case of Nos. 22 and 24 2nd grade cream, to which 20 per cent of starter had been added received a higher average score than that from any of the number one cream to which less starter was added. The butter from the 1st grade cream scored higher, however, when the same per cent of starter was added to each grade of cream. A glance at the table showing the per cent of starter used will show the difference. Only 5 per cent of starter was used on the 24th, having been introduced a few days previous by the Experiment Station official in charge, and on the 25th when a sufficient supply was propagated 20 per cent was used in the 2nd grade cream. The Baltimore market scored the butter as a whole lower than the Washington market. The latter judges placed all of the samples except Nos. 3 and 33 in the "Extra" class, with 3 and 33 as seconds and in one instance thirds, making a difference of three to eight cents a pound. On March 27 when the scoring was done in Washington, the market quotations were as follows: Creamery extras 32 and 33, firsts 30 to 31, and seconds 22 to 24. The Baltimore market at this time quoted extras at 32, firsts, 30 and seconds 20 cents. Although the scoring done in this market at this time seems rather inconsistent it is evident that the butter made from second grade cream without the use of starter was far below that from the same cream to which starter had been added. The difference in price on the Baltimore market at that time was ten cents a pound. While as a whole the grading was beneficial the pasteurization and use of starter was still more beneficial,.

One of the most important observations made in this experiment is that of the difference in overrun between first and second cream. The temperature of the wash water and other conditions remained constant, and were not allowed to vary with daily conditions existing at the creamery.

The mixed cream gave an overrun of 10.19 per cent, that of number one gave 12.28 and 18.01 per cent. Number two cream produced an overrun of only 4.86 and 7.54 per cent where starter was used, and no overrun without the use of starter.

This difference in overrun on 900 pounds of cream, the average amount churned at that time, is demonstrated in the following table:

900 lbs. cream 30% fat equals 270 lbs. butter fat.

Overrun	10.19%,	297.51 lbs. butter at 30c.	$89.25	Mixed Cream
Overrun	12.28%,	303.16 lbs. butter at 30c.	90.94	No. 1 Cream
Overrun	4.86%,	283.12 lbs. butter at 30c.	84.93	No. 2 Cream
Overrun	18.01%,	318.63 lbs. butter at 30c.	95.58	No. 1 Cream
Overrun	7.54%,	290.36 lbs. butter at 30c.	87.11	No. 2 Cream
Overrun	0.00,	270.00 lbs. butter at 30c.	81.00	No. 2 Cream— (without starter.)

The per cent of moisture retained in the butter does not bear a constant relation to the per cent of overrun obtained. This is probably due to the fact that milk fats vary in their power to absorb moisture in a liquid state. The better grades of cream, however, appear to be in a condition to retain more fat in the butter produced therefrom and consequently more water, although the per cent of water may not be increased. In the churning of the second grades of cream it will be noticed that the per cent of loss in manufacture was much greater than that of the first grade of cream.

This is a very significant point in the manufacture of a uniform product. Figuring on a uniform overrun 15, 18, 19, 5, 12, and 8 pounds of salt were used in the butter of the churnings at the Cold Spring creamery. The variation of overrun caused the amount of salt per pound of butter to be as follows:

April 18	No. 1, .85 oz. per lb.	No. 2 .85 oz. per lb.	No. 3, .9 oz.
April 25	No. 1, .82 oz. per lb.	No. 2 .87 oz. per lb.	No. 3, .84 oz.

As in the previous experiments we have a variation in the amount of salt used per pound of butter, and for the same reason. The buttermaker did not test his cream each time before churning and was permitted to salt the butter after his usual methods, according to weight of cream, and the variation in the amount of salt per pound of butter is accordingly noted in the table. Uniform butter cannot be made by such a procedure.

The Sparrows Point Store creamery received a poor quality of milk as a whole, but with careful and sanitary methods produced a fair quality of butter. Had the use of starter been employed with their pasteurization a far better and more uniform grade of butter could have been produced. Pasteurization merely destroys the most of the bacteria present in the milk, including all of the lactic acid producing oragnisms. When thus allowed to ripen without the addition of starter from lactic acid culture, a flat flavor is produced and the organisms that have withstood the pasteurizing temperature frequently develop undesirable flavors in the butter.

All of the butter from the Easton creamery scored low. Although some of the milk received was of a very poor quality the conditions there were the least conducive to the correction of any such fault.

A COMPARISON OF DAIRY CONDITIONS ON THE FARMS OF MARYLAND CREAMERY PATRONS

It was interesting to note the remarkable manner in which the farm conditions compared with the score of the milk at the creameries. The milk from farms where the more sanitary conditions prevailed generally scored higher than that from the farms where conditions were less sanitary.

Most of the barns were deficient in light and ventilation, and the manure piles were frequently too near the barn doors. Many of the ceilings were not tight and chaff and dust sifted through. These were the prevailing faults on the farms of the patrons of the creameries in Frederick, Carroll, Baltimore and Harford counties: Among the most desirable conditions was the prevalence of an inexhaustible supply of clear, cold spring water, which upon examination contained an average of only 100 bacteria per cc. With but few exceptions the patrons had spring houses with such water running through them. In some cases, however, vegetables and other objectionable material was kept in the same room with the milk.

Some of the patrons and their help milked with wet hands, some used hot water for rinsing their dairy utensils, but in almost every instance rinsed them again with cold water. This naturally counteracted the sterilizing effect of the hot-water rinsing.

Some of the milk was cooled rapidly by setting the cans in cold water and stirring the milk with a long-handled dipper. Such milk generally scored high at the creamery. Some of the patrons allowed their milk to set in the water without stirring and with the can covers tightly closed. This milk cooled very slowly and invariably had a musty flavor.

In Talbot County the creamery patrons' barns were on the whole more sanitary than those of the other counties previously mentioned. Although some of the barns lacked light and ventilation many of them were open on the south side. Of these, some were almost ideal, for this section, being whitewashed and having tight board roofs. Most of them, however, had only straw roofs which allowed chaff to sift through. All of the dairy farms visited in Talbot County possessed good well water, but few of them had running spring water or spring houses, as did those of the northern counties of Maryland. The patrons were mostly interested in diversified truck farming, with a few cows and a dairy as a side issue.

CREAMERY CONDITIONS, THE CAUSE OF LACK OF UNIFORMITY IN MARYLAND BUTTER

From these results and from personal observation of existing conditions in the dairies and creameries included in these investigations it is obvious that the cause of lack of uniformity in the butter produced in Maryland is due to the lack of proper methods and equipment in the creameries to control seasonal fluctuations in the quality of the milk and cream, or even the variations arising from daily bacterial contamination of a promiscuous milk supply.

Of the five creameries in question only two had pasteurizers. Starter was used in only one of these, after having been introduced by the Experiment Station representative.

Not one of the five buttermakers or managers in charge had any technical training in their line of work. One buttermaker had previously been employed as a motorman on a Baltimore street car; one had been a blacksmith, and the other three had come directly from farms. None of them knew how to control the per cent of overrun, and only one graded the milk and cream and churned each grade separately.

Three of the proprietors kept stores, two of which were so situated as to permit the patrons to do their trading while waiting for their skim milk.

Four of the managers ran huckster wagons and brought country produce such as poultry, eggs, veal calves, etc. The proprietor of the fifth creamery held a county office from which he received his chief income. Their creamery business therefore, consisted of merely a part of their occupation.

Only one of the creameries refused to accept garlic tainted milk while the others made a semblance of butter from any and all grades of milk or cream that was delivered.

At none of the creameries was the milk delivered daily during this season of the year and at three of them it was delivered only twice or three times a week. That is, some of the patrons delivered milk three times a week and the others delivered theirs only twice.

Different degrees of sanitation prevailed at each creamery.

Cream was ripened at temperatures varying from 45° to 80° F. in two of the creameries, from 50° to 70° in two others and from 50° to 60° F. in the other. The practice of pastuerizing the water used for washing butter was in vogue in none of these creameries.

These observations together with the fact that most of the creameries of the State make butter only a part of each year and ship cream the remainder of the year, making no specialty of either, explains the cause of variation in the creamery butter of Maryland.

CAUSES OF POOR QUALITY OF MARYLAND BUTTER

1. As may be seen from the foregoing tables the average score of all grades of milk as it arrived at the creameries was 75.8, the average according to grade was as follows: first grade 86.9, second grade 71.7, and third grade 67.4. These grades of milk were all churned together at four of the creameries, while at only one was it graded and the cream churned separately, making two grades of butter.

2. Three of the creamery managers endeavored to instruct their patrons as to the proper methods of caring for their milk, methods of sanitation, etc. The other two gave no such instructions and from the conditions of their creameries there was no such precedent established there.

3. Garlic was reported in the spring and fall of the year on every farm visited, but was only noticeable at one creamery during the time of these investigations.

The prevalence of garlic in Maryland during the spring and fall of the year is detrimental to the butter produced at these seasons where cows are allowed to run on pasture.

4. There is a lack of proper sanitation on the average Maryland dairy farm, the most deficient points of which were: lack of proper light, ventilation, and cleanliness of dairy barns, milking unclean udders with wet hands, use of unsterile dairy utensils, and improper cooling of milk.

5. There is a lack of technical training in dairy lines among the buttermakers of the State which would enable them to properly grade the milk as it is received at the creamery, pasteurize it, make good starter, properly ripen cream, control their overrun, and instruct their patrons in methods of producing sanitary milk and cream.

6. The majority of the creamerymen of the State are engaged in other occupations and devote only a part of their time to the creamery business.

7. The majority of the creamery patrons are engaged in diversified farming and dairying is only a side issue with them.

SUMMARY OF DATA OBTAINED FROM CREAMERIES

On February 15 inquiries were sent to all of the principal creameries of Maryland and to the commission houses of Baltimore to ascertain their opinion of the butter situation of the State.

Twenty-six replies were received from creamery operators, nine of whom had gone out of business. Three replies were received from commission men.

The answers according to the order in which the questions were sent are as follows:

Question 1. How long has your creamery been in operation?

Answers:

30 years
22 years
21 years
21 years
Six 20 years
18 years
15 years
Three 10 years
6 years
2 years

Question 2. How many patrons or farms do you receive milk from?

The number varied from 3 to 167, the average being 50.

Question 3. Do they deliver milk or cream?

Six answered milk, one cream, and six said both.

Question 4. Do they deliver every day?

Three answered yes, and nine said that their patrons delivered six times a week during the summer and three times a week during the winter. One stated that 90 per cent of his patrons delivered every day and the others three times a week. The last one said that his milk patrons delivered three times a week and his cream patrons only twice a week.

Question 5. Do you make the product into butter, ice cream, or sell cream?

Two answered, "butter;" two, "ship cream;" one, "sell condensed milk;" one, "ice cream;" one, "cream and ice cream;" one, "butter and cream;" one, "milk and cream," and four answered, "butter, cream, and ice cream."

Question 6. Where do you market your products?

Two answered, "Baltimore;" two, "Philadelphia;" one, "Philadelphia and Wilmington;" one, "Baltimore, Washington and Pittsburg;" one, "Chambersburg, Pennsylvania;" one, "Baltimore, Wilmington and Philadelphia;" one, "Middletown, Delaware;" one, "Baltimore, Frederick, Westminster and Walkersville;" one, "home trade;" one, "Baltimore and Philadelphia;" one, "different cities;" and one, "local towns."

Question 7. How much milk or cream do you handle per day?

The answers were as follows:

6000 to 12,000 lbs. milk per day
6000 lbs. milk and cream per day
1000 lbs. milk per day
45,000 lbs. milk per day
1200 to 5000 lbs. milk per day
6000 to 12,000 lbs. milk per day
8000 lbs. milk per day
80 to 240 lbs. cream per day
1000 to 2000 lbs. cream per week, 300 to 600 lbs. milk per day
3000 lbs. milk per day
4000 to 8000 lbs. milk per day
44 lbs. cream per day
1000 lbs. milk, 325 lbs. cream per day
1500 lbs. butter per wk.; 250 per day
2850 lbs. milk and 80 lbs. cream per day.

Question 8. On what basis do you purchase milk and cream; by the hundred or by the fat test?

Nine answered, "By fat test;" two, "by the hundred pounds;" one, "on 4 per cent basis;" and three, "by fat test and per gallon." We suppose that "on the 4 per cent basis" indicates that he pays by the hundred pounds and requires that the milk test 4 per cent butter fat.

Question 9. Does your butter sell for more or less than the standard Elgin butter?

Six answered, "about the same;" three answered, "more;" one, "above standard except in garlic season;" three answered "less;" and one wrote "cannot answer."

Question 10. Do your patrons furnish you with clean, sweet milk and cream of good quality and good flavor?

Five answered, "Yes;" one, "fairly;" one, "yes, as a rule;" three answered, "yes, except in garlic season;" one, "except in hot weather;" one, "some do, others do not;" one, "not many, mostly poor;" one, "need improvement along that line;" two, "We only accept sweet milk."

Question 11. Do you grade your cream and make more than one grade of butter. If so what is the difference in the selling price of the different grades of butter?

Eight answered, "no;" one, "some;" one, "in a way;" one, "in garlic season;" and five did not answer the question. They evidently did not grade milk.

Question 12. What suggestions can you make for improving quality of milk and cream delivered at your creamery?

Many of these answers were in part the same, differing in some particulars. To avoid repetition by quoting each, the answers are all included in the following summary:

Better dairy laws, better cows, better care of cows, milk and dairy utensils, including prompt cooling of milk and scalding of cans and pails. More frequent delivery, skimming thicker cream, enforcement of sanitation, prohibiting manufacture of butter on the farms, refusing to accept unclean milk at creamery, and recommending of silage for dairy cows.

Question 13. What means do you adopt for encouraging your patrons to supply more and better milk and cream?

One answered, "none;" one, "the elimination of colored help;" one recommended the reading of dairy papers; one held an annual farmers' meeting; three paid higher prices for best grade of milk; two encouraged their patrons by argument; one tested individual cows separately for his patrons, thus aiding them in eliminating their poorest ones, and two were giving prompt service and a square deal.

Question 14. Do you pasteurize your milk or cream?

Six answered, "No;" four answered, "Yes;" one pasteurized cream during the entire year; one only during the winter, and one during the summer. Two pasteurized the milk before separating and one pasteurized "Some of it."

Question 15. Do you use a starter for ripening cream?

There were only eleven answers to this question, those not answering were evidently in the negative list. Five answered "No;" five, "Yes;" and one said he used it only in the winter.

Question 16. Do you pasteurize the skimmed milk before it is returned to the farmer?

There were twelve answers to this question, the blank spaces indicating, as in the above, a negative reply. Ten answered in the negative and two in the affirmative. Two pasteurized their whole milk and that sufficed for both.

Question 17. How long and at what temperatures do you hold cream from time of separating until churning?

Only nine answers were received to this question, which indicates that the others kept no record of their methods of ripening cream. The answers were as follows:

Eighteen hours at 55° F.; cool to 55° F., and let sour one day in summer and longer in winter.

"Twenty-four hours at 60° F."

"Two days at 60° F."

"Sixty degrees in winter and fifty-two in summer; about 60° F."

"Churn four times a week in winter and six in summer."

"Separate one day and churn the next morning."

Question 18. At what degree of acidity do you churn your cream?

There were only six answers to this question, the others probably made no acid tests. The following answers were received: "Have never learned that degree;" "Don't know;" "Have no acid test;" "Have never used an acid test, but churn when cream has sharp acid taste;" ".55," and "About .4 or .5."

Question 19. How long and at what temperature do you hold butter from time of churning until shipping?

Only one answer indicated that such temperatures were observed. This answer was "About 50." Five shipped at once, one the next day after churning; one held at lowest temperature obtainable for six to eight hours, and two shipped twice a week in summer and once a week in winter.

Question 20. What quantity of salt and coloring do you use in your butter during the different seasons of the year?

To this question there were twelve answers. Two used color and salt according to demand of their trade; three used one ounce of salt per pound of butter, one used one-fourth to one ounce of salt; one used three-fourths to one and one-fourth ounces per pound and one, "Salted twice, using six pounds each time." Two said they used a little color, one used one ounce color to 40 pounds butter in winter and an ounce to 60 pounds butter in summer. One used one ounce color to 30 pounds butter fat; one used from one-fourth ounce in summer to one and one-half ounces in winter, and one used an ounce to 25 gallons of cream. The gentleman who "Salts twice, using 6 pounds each time" evidently uses 6 pounds of salt per 100 pounds butter, then washes once, and adds another 6 pounds of salt.

Question 21. How many times do you wash your butter, and what is the temperature of the wash water used?

There were only eight answers to this question. Three answered "once;" one indicating the temperature at 54° F. and the others did not give temperature. Three wash their butter twice with water at 55° F., one of these uses ice water in the summer; one washes three times with water at 50° F., and one washes once unless cream is very sour, then he washes twice.

Question 22. Do you pasteurize the wash water before washing your butter?

Only nine answers were received to this question and all were in the negative.

Question 23. What is your average per cent of overrun during the various seasons of the year?

To this question there were but eight answers, indicating that the others did not know what their overrun was. One answered, "It's rather hard to get at, larger in the summer than in the winter." One wrote, "Don't know;" two, "10 per cent;" one, "12 to 16 per cent;" one, "12 to 15 per cent;" one, "10 per cent for milk and 20 per cent for cream;" and one, "15 to 18 per cent."

Question 24. What suggestions could you make for the improvement of the creamery butter of your county?

To this question there were seven answers as follows: "Reading dairy papers and attending farmers' meetings;" "Cheaper labor and better milk;" "Good square talk with the farmers;" "A creamery association pledged to purchase only good cream;" "Get rid of garlic;" "Better cows and milk;" "Pasteurizing cream, prohibiting farmers from making butter, compelling creameries to be kept in a sanitary condition, and a better and more scientific knowledge of the process of butter making."

Question 25. Would a course of instruction in the modern methods of making butter be of value to your buttermaker?

Eight answered in the affirmative, and one wrote "I don't think so."

Question 26. Would your buttermaker attend such a course of instruction if given free either at the Experiment Station or some central location?

Eleven answers were received to this question, nine in the affirmative; one wrote "Do not know," and another wrote "If possible."

Question 27. Where would you suggest as the best place and time to give such a course?

Two answered "Now;" one, "Baltimore or Hagerstown;" two, "In winter, at Frederick;" three, "At the Experiment Station during the winter months;" one, "At Hagerstown in May or June;" one, "At the Calvert High School;" and one, "Any time and anywhere."

The three replies from the Baltimore commission men are as follows:

Question 1. Do you handle the product of Maryland creameries or home dairies?

All answered "No."

Question 2. If not, why ?

1. "I cut it out several years ago when the artificial article was at its best." 2. "This is merely a distributing plant, our own make being shipped from the West." 3. "Use only Pennsylvania products."

Question 3. Approximately how much Maryland butter do you handle monthly?

All answered "None."

Question 4. What season of the year do you handle most of the Maryland product?

One answered "Did handle it in May, June and July."

Question 5. What are the defects you notice in the Maryland product and what do you consider causes them?

One answered, "Garlic and grass in the spring and the color used the rest of the year."

Question 6. At what season of the year are the defects most apparent?

One answered, "May, June and July."

Question 7. Have you ever given your patrons advice or instruction for improving their product?

One answered in the affirmative.

Question 8. How was the advice received and with what results?

One answer, "Not heeded."

Question 9. Give all the suggestions you can for the betterment of Maryland butter and the improvement of the creamery industry.

No answers were received to this question.

LIST OF CREAMERIES

This list of creameries is no doubt incomplete, but it is as nearly accurate as it could be made at this date. Any person who knows of a creamery not on this list will do a favor by advising the Experiment Station of the name and location of the same.

Baltimore County

1. White House Creamery Company, Upperco, Md.
2. Monkton Creamery, Monkton, Md.
3. Walnut Grove Creamery, Beckleysville, Md.

Caroline County

4. Enterprise Creamery, Preston, Md.

Carroll County

5. Winfield Creamery, Winfield, Md.
6. Taneytown Creamery, Taneytown, Md.
7. Myers & Arthur Creamery, Frizzellburg, Md.
8. Greenmount Creamery, Greenmount, Md.
9. Cold Spring Creamery, New Windsor, Md.
10. Hampstead Creamery, Hampstead, Md.
11. Norman Creamery Unionville, Md.
12. Harmony Creamery, Sylmar, Md.
13. York Road Creamery, York Road, Md.
14. Mt. Pleasant, Westminster, Md., R. F. D.
15. Melrose Creamery, Westminster, Md.
16. Mt. Airy Creamery, Mt. Airy, Md.

Queen Anne County

17. Centerville Creamery, Centerville, Md.
18. Millington Creamery, Crumpton, Md.

Cecil County

19. Warwick Creamery Co., Warwick, Md.
20. Elkton Creamery, Elkton, Md.
21. Chesapeake City Creamery, Chesapeake City, Md.
22. Bethel Creamery, Pivot, Md.
23. Lombard Creamery, Lombard, Md.

Dorchester County

24. Enterprise Creamery Company, Hurlock, Md.
25. Enterprise Creamery, Ellwood, Md.
26. East New Market Creamery, East New Market, Md.

Frederick County

27. Emmittsburg Creamery, Emmittsburg, Md.
28. Cramer's Creamery, Walkersville, Md.
29. Liberty Creamery Company, Libertytown, Md.
30. The Oyster Creamery Company, Walkersville, Md.

31. Le Gore Creamery, Le Gore, Md.
32. Mountain City Creamery, Frederick, Md.
33. Sparrows Point Store Company, Creamery Mt. Pleasant, Md.
34. Shank Bros. Creamery, Middletown, Md.
35. Buckeyestown Creamery, Buckeyestown, Md.
36. Knoxville Creamery, Knoxville, Md.

Harford County

37. Harford Creamery Company, White Hall, Md.
38. Upper Crossroads Creamery, Upper Crossroads, Md.
39. Salem Creamery, Fallstown, Md.
40. Gilt Edge Creamery, Pylesville, Md.
41. Jerrettsville Creamery, Jerrettsville, Md.

Kent County

42. Kennedyville Creamery Company, Kennedyville, Md.
43. Massey Creamery, Massey, Md.
44. Worton Creamery, Worton, Md.
45. Clendaniel & Company's Creamery, Kennedyville, Md.

Talbot County

46. Easton Creamery Company, Easton, Md.

Washington County

47. Maugansville Creamery, Maugansville, Md.
48. Mountain View Creamery, Smithburg, Md.

SUGGESTIONS FOR OPERATING AN AVERAGE MARYLAND CREAMERY

1. Secure Competent Buttermaker

The first step after a creamery is built is to secure a competent buttermaker who has completed a dairy course at some good dairy school. Such a man will be helpful in securing and arranging the creamery machinery and apparatus as follows:

2. Arrangement of Machinery

Have weigh-can conveniently arranged on scale at delivery platform, a tin spout so adjusted as to run the milk into either of two vats, one for first and one for second grade milk. A pasteurizer and cream separator should be placed near these vats where the best grade of milk may be pasteurized and separated first and the second grade immediately after. A double cream ripening vat containing a coil of pipes for warm and cold water should be placed near enough to the separator to receive the cream, which may be conducted into either division according to grade.

A starter-can should be placed convenient to the ripening vats from which the cream enters, the spouts or gate valves of the vats being on the ends near the churn. A space for the butter printer should be made on the opposite side of the churn, and beyond that the refrigerator or cold storage room. This arrangement of the creamery machinery may be in a line or in circular form to suit the convenience of the building, providing the building has not been made so as to suit the arrangement of the machinery it is to contain. The wash tank with water and steam connections may be arranged in the most convenient place, where shelves are placed for drying creamery apparatus after steaming. A supply of pipe wrenches and other necessary tools should be placed in a convenient place in the boiler, engine, or test room.

A Babcock tester and acid tester with sufficient glassware should be arranged in a small test room where the temperature may be regulated. All minor apparatus should be arranged with a view to convenience.

Ample light and ventilation should be provided.

The following conveniences may be installed with profit at the option of the buttermaker and the financial condition of the proprietors.

Creamery Conveniences

A large fan to keep the air fresh and the flies out.

A low-water whistle alarm on the boiler as required by law in some states.

A cord connected to the safety valve on the boiler and stapled around the periphery of the creamery, with a weight attached sufficient to pull the valve open if the cord is ever burned in two. In case of fire the steam and hot water will aid materially in extinguishing it.

An automatic scale to show the weight of the milk as soon as emptied into the can.

The butter printing table fastened on the wall, with hinges and drop legs.

Pipe brushes with sectional handles to clean milk pipes.

A heater regulator to control the temperature of milk when separating; also cream when pasteurizing.

Steam and water connections with hose to wash vats, walks and floor.

Cases for separator and pasteurizer parts hung neatly on the wall near the machines.

A case similar to the above for a complete set of creamerymen's tools.

An oil cloth to cover the engine, separator, and pasteurizer when not in use, to keep off the dust.

3. Grading Milk

As the milk arrives at the creamery refuse to accept all sour milk, or any which is unfit for human consumption. Weigh milk promptly, place samples in composite sample jars, and grade each lot by taste and smell. It requires time to learn to grade milk accurately, but a cultivated taste is gradually acquired, and most buttermakers learn to grade milk in a few weeks' time.

4. Operating Creamery

The pasteurizer and separator should be started as soon as there is a sufficient amount of the best grade of milk on hand to insure a continuous run until all of the patrons arrive. Heat milk to 170° F. in a continuous pasteurizer and cool to 85° F. before it enters the separator. This rids the cream and also the skimmed milk of most of the undesirable bacteria, including all tuberculosis germs. This, together with washing and steaming the patrons' cans before filling them with skimmed milk, would prevent the spread of tuberculosis or most other infectious diseases. The importance of such pasteurization cannot be overestimated since hogs have been found to be more susceptible to tuberculosis than any other domestic animal.

Ridding the cream of the majority of the bacteria present leaves a comparatively clean field for the lactic acid bacteria which are added in the starter to produce a good and uniform flavor in the butter from day to day.

After pasteurizing and separating the best grade of cream should be allowed to run into one division of the cream ripening vat and the second grade into the other division. It should be cooled to 70° F. by revolving the coils containing cold water. At this temperature the starter should be added and the cream allowed to ripen. The best flavor is produced in butter from cream ripened at this temperature.

From 10 to 30 per cent of starter should be added, depending upon the acidity of the cream as it reaches the ripener and the length of time it is to remain there before churning. Cream is usually churned the following morning after it arrives, and where this method is practised should be ripened at 70° F. to about .4 per cent acid and gradually cooled to 50° F. over night.

Stir cream occasionally to insure uniform ripening.

Making Starter

Starter is made by sterilizing a clean flavored batch of sweet skimmed or whole milk by running it through a pasteurizer and heating to about 212° F., preferably two days in succession. Allow some of the milk to run into a sterile quart bottle. Cover bottle as soon as full and cool to 88° F. Add contents of capsule or bottle of commercial culture of lactic acid bacteria and allow to remain at 80° F. until it becomes partially thickened, or has the consistency of thick cream. This usually requires from eight to twelve hours. Pour from the top of the bottle into the starter can containing from five to ten gallons of pasteurized milk the contents of the bottle with the exception of about a teaspoonful. Put the spoonful of starter remaining in the bottle into a clean sterile bottle and add enough pasteurized milk to continue the propagation of original culture, being careful thereafter to hold at 70° F. for a few hours. Then cool to a low temperature or it will become over ripe and whey off.

Having been ripened and cooled to 50° F. during the night the cream should be churned at that temperature in the summer and at about 55° F. in the winter.

The method of churning sweet cream, described on page 274 will be found feasible for many buttermakers.

A sample of cream should be tested for butter fat, so as to accurately calculate the amount of butter obtainable and to know exactly how much salt to use. The testing may be most conveniently done for each churning on the afternoon of the day previous to the churning.

Also make an acid test of the cream at this time so as to regulate the acidity and have it uniform from day to day.

Weigh or measure the cream as it is put into the churn and calculate the amount of butter fat as follows:

Example

500 × .30 = 150 ÷ 6 = 25
25 + 150 = 175 lbs. br.

500 lbs. cream,
30 per cent fat,
6)150.0 butter fat.
25 overrun at 16.6 per cent
175 butter
Using 1 oz. salt per lb. butter .... 16)175 oz. salt.
10.9 lb. salt.
Color in winter 1 cc. per 2 lbs. butter fat, 2)150 butter fat.
75 cc. color.

Where measuring is more convenient than weighing the following standard weights may be used:

1 gallon cream testing 15 per cent fat weighs 8 pounds 7 ounces.
1 gallon cream testing 20 per cent fat weighs 8 pounds 6½ ounces.
1 gallon cream testing 25 per cent fat weighs 8 pounds 6 ounces.
1 gallon cream testing 30 per cent fat weighs 8 pounds 5½ ounces.
1 gallon cream testing 35 per cent fat weighs 8 pounds 3 ounces.
1 gallon cream testing 40 per cent fat weighs 8 pounds 1 ounce.
1 gallon cream testing 45 per cent fat weighs 7 pounds 15 ounces.
1 gallon cream testing 50 per cent fat weighs 7 pounds 14½ ounces.

Before churning each morning rinse churn with hot water from 150 to 200° F., revolve it from five to ten times, being careful to leave stopper out. Draw off water and rinse again in the same manner with pure cold water at about 50° F., leaving stopper in during last rinsing. Draw off water and pour the ripened cream in, filling churn about one-third full, so as to allow the greatest splash when churning. Add vegetable coloring the amount depending on the time of the year and market requirements. Put cover on tight and set churn in motion, removing stopper two or three times during the first part of the churning to allow the moist air to escape.

When the butter has gathered in granules the size of number 4 to 00 shot stop churn and draw off buttermilk. Rinse once using one-quarter of the churnful of sterile water (water which has been boiled and cooled) about the same temperature of the butter, revolving churn about three times. Draw off and if rinse water still has milky color rinse again. Otherwise not. Add salt depending on your market requirements. Keep salt in dry place and for best results it should not be colder than butter when added. Salt must be distributed evenly to prevent mottling in butter. This is best done as follows: Pulverize salt and distribute as evenly as possible. Throw workers into gear, using low speed. Revolve churn about ten times and allow to stand for twenty minutes to give the salt a chance to dissolve evenly. Work ten revolutions more, take out, and print or pack in cases or tubs which have been previously scalded and coated on the inside with paraffin.

Prints should be cut with square corners and neatly wrapped. Tubs should be lined with circles and liners that have been previously soaked about twelve hours in a cool brine solution to destroy mould and undesirable bacteria.

Calculate the per cent of overrun as follows:

Example

175 − 150 = 25
25 × 100 = 2500 ÷ 150 = 16.6 per cent

175 lbs. butter.
150 lbs. butter fat.
25
100
150)2500(16.6 per cent
150
1000
900
1000
900

Percentage of overrun	*Pounds overrun on 100 b. butter fat*	*Value of overrun at 25c. per lb.*
20	20	$5.00
18	18.0	4.50
16	16.0	4.00
15	15.0	3.75
13	13.0	3.25
9	9.0	2.25
5	5.0	1.25

The overrun may be controlled to a great extent by the temperature of the butter and the temperature of the water used. The warmer the butter the more water it will absorb providing the water is not too cold.

Washing butter with very cold water, below 50° F. chills the grain causing it to contract and expel moisture, consequently producing a low overrun.

For best results the temperature of the butter should range between 50° and 60° F. when churned (50° to 55° F. in the summer and 55° to 60° F. in the winter) and the wash water should be within one degree of the temperature of the butter when washed.

The incorporation of too much water is both detrimental and unlawful. The legal moisture limit is 16 per cent.

Keep butter in cold storage until ready to ship and ship in refrigerator cars if possible. Samples of the skim milk and buttermilk should be tested daily, and the loss of fat reduced to a minimum.

A butter maker should be absolutely accurate in the use of the Babcock test, sampling milk, keeping books, and should be able to instruct his patrons in methods of sanitation in handling their milk, proper balancing of rations for dairy cows, and general dairy management for obtaining best results.

SUGGESTIONS TO CREAMERY PATRONS

It is impossible to make first-class butter out of tainted or otherwise defective milk. It is possible under Maryland conditions to send cold, sweet, first grade milk to your creamery at all times during the year. No State in the Union possesses a better supply of clear, cold, spring water. It is only necessary to observe a few simple rules of sanitation in order to produce the best grade of milk. Thoroughly wash all dairy utensils with some good washing powder each time after using, and then rinse with boiling hot water to destroy all germs. Expose them to direct sunlight during the day when weather permits. Brush each cow's side and udder with a damp cloth or sponge before milking. Milk with clean dry hands. Discard the first stream of milk from each teat so as to rinse any invisible dirt out of the teat duct. Cool each cow's milk in pure atmosphere immediately after milking. This may be done by use of cooler and aerator placed in the spring house, or by placing in a narrow can surrounded by cold water, and stirring the milk with a long-handled dipper or stirring rod. A boy may carry each cow's milk to the spring house as fast as they are milked and return the empty pails as others are filled.

No vegetables, meat or anything that will impart an odor or flavor to the milk should be kept in the milk room.

After the milk is cool place covers tightly on cans and keep as cold as possible until delivered. During the summer use wet gunny sacks or heavy blankets to cover cans enroute to the creamery. See that your cans are washed and steamed at the creamery before filling with skim milk. Insist on having the skim milk pasteurized so as to prevent contamination from tuberculosis.

Keep your dairy barn clean, whitewashed, light, and well ventilated. See Government score card for amount of light necessary.

Feeding and bedding of cows should be done after milking, as the dust contains bacteria that spoil the milk.

Milk is one of the best foods for bacteria and the undesirable germs grow rapidly in this fluid while warm. Therefore, keep them out as far as possible by sterilization and cleanliness, and then cool the milk immediately after milking to check the growth of those that do find their way into it.

SUGGESTIONS FOR BUTTER MAKING ON THE FARM

When butter is made on the farm the same rules as given for creamery butter making in the foregoing pages of this bulletin will apply in a general way.

Cream should be ripened at about 70° F. and if possible with a starter from lactic acid culture as previously described. Home-made starter may be used if care is exercised in making. Use perfectly clean skimmed, or whole milk which has been allowed to sour in a sterile, well-covered can at 70° F. Starter is nothing but a clean flavored batch of sour milk. When thickened to the consistency of thick cream it is ready to use. Starter should not be added when overripe (wheyed off), as the lactic acid forming bacteria will be inactive and the curd will appear in white specks in the butter.

Any small can with a tight-fitting cover may be substituted for a starter can. When cream begins to turn sour it should be cooled to 50° F. and held at this temperature until ready to churn. This gives the butter a firm texture when churned.

Rinse churn with hot water, then with pure cold water if in summer. In winter the cold water rinsing is unnecessary. Place cream in the churn at about 55° F. in the summer and 60° F. in the winter. Add color to suit taste. Fill churn about one-third full and turn crank at speed which will allow the greatest splash in churning. Stop churning when butter granules are about the size of a wheat grain. Draw off buttermilk. Rinse butter with pure cold water until rinse water runs off almost clear. Salt may be added to suit taste; an ounce per pound of butter is usually sufficient. Work salt in by pressing butter worker or paddle straight down without drawing it over the surface. Where a paddle is drawn across the surface of the butter the grain is not only spoiled but the butter has a greasy taste and appearance. Pack well, exclude as much air from the jar as possible by use of clean damp cloths and keep in the coldest place on the farm.

INVESTIGATIONS IN THE MANUFACTURE OF SWEET CREAM BUTTER

The growing demand for sweet cream butter for fancy trade in many of our large cities, the economy of labor derived from churning sweet cream, thus eliminating the process of cream ripening, and thereby reducing the danger of the development of undesirable bacteria and further contamination during the process, suggested the following experiments:

1. Churning normal sweet cream in comparison with ripened cream.
2. Churning normal sweet cream to which starter has been added.
3. Churning sweet pasteurized cream to which starter has been added.
4. Churning sweet cream to which commercial lactic acid has been added as a substitute for starter.
5. The addition of lactic acid to butter in the churn and working it in.
6. The addition of warm skimmed milk as a substitute for heating cream to churning temperature during cold weather.

In these investigations starter was made from skim milk in the usual way as described on page 264. Starters were also made from whole milk and cream, and the results obtained by their use compared.

Natural starter was also used in comparison with starter made from commercial cultures.

Natural starter is made by allowing a clean, flavored batch of milk to sour and thicken to a creamy consistency by the normal process at about 70° F. The chief difference between natural and commercial starter lies in the fact that the latter contains practically a pure culture of lactic acid bacteria while the former contains many other germs which reduce their effect, and frequently produce undesirable flavors.

All starters were used and propagated similarly after making.

Experiments were also made by adding lactic acid directly to cream and by adding it directly to butter in the churn and working it in.

Pasteurization was effected by heating at from 150 to 180° F. and cooling immediately. Also by maintaining these temperatures for twenty minutes.

To determine the effect of pasteurizing temperatures on the bacterial content of cream, plate cultures and acid tests of the cream were made after pasteurizing at various temperatures with the following average results:

TABLE I

	Bacteria per cc.	*Acid content at the end of 24 hours at 60° F. Per cent acid.*
Normal unheated cream	25,000	.67
Cream pasteurized at 180° F. not cooled	1,000	.3
Cream pasteurized at 180° F. cooled to 80° F.	150	.28
Cream pasteurized at 180° F. cooled to 50° F.	30	.25
Cream pasteurized at 170° F. not cooled	1500	. 3
Cream pasteurized at 170° F. cooled to 70° F.	200	.29
Cream pasteurized at 170° F. cooled to 50° F.	45	.26
Cream pasteurized at 150° F. not cooled	4000	.3
Cream pasteurized at 150° F. cooled to 50° F.	250	.29

As illustrated by the above table immediate cooling proved a very important part of pasteurization in reducing the germ content of the cream, especially when the pasteurizing temperatures did not exceed 150° F.

Exposure to sudden changes of temperature destroyed or inhibited the bacteria almost as readily as did the heating alone. Doubtless some of the bacteria in the cooled cream were obtained from the air during the process of cooling. Pasteurization checked the development of acid in cream by destroying the lactic acid bacteria present.

The investigations were conducted from January 1, 1907, to January 1, 1909, a churning being made from one to four times a week for several weeks during every season of each year. The results of the investigations were therefore obtained from observations taken from 125 churnings. The cream used in this work, with the exception of experiments conducted at the Mt. Pleasant creamery, was obtained from milk of the Station herd, milked in Gurler sanitary milk pails, and separated and churned as soon as properly cooled (held at 50° F. or below for at least two hours). The average score of the cream obtained from the Station herd during this period was 96. This must be borne in mind in considering the greater differences resulting from the use of a low grade of cream. This also accounts for the higher average scores of butter from the Station cream than from that of the creamery.

The cream was graded on the basis of the following points:

PERFECT SCORE

Flavor:		*Condition:*	
Taste	30	Cleanliness	20
Smell	30	Acidity	20
Total			100

In all of the investigations the water used for washing butter was boiled and then cooled so as to prevent contamination from that source.

The scoring was all done by experts, the U. S. Dairy Division frequently furnishing judges for this purpose.

The average score of the butter made by the various methods, together with the loss of fat in the buttermilk when churned under identical conditions during the two years, is illustrated in the following table:

TABLE II.

Ripened Cream in These Tables Indicates Souring Until it Contains From 0.5 to 0.6 Per Cent of Lactic Acid.

SWEET CREAM (containing 0.2 per cent acid; average score 96.)

		SCORE OF BUTTER.				PER CENT FAT IN BUTTERMILK.		
		Pasteurized at			Unpasteurized.	Churned below 48° F. and warm milk added.	Churned at 50° F.	Churned at 55° F. to 60° F
		180° F.	170° F.	150° F.				
						per ct.	*per ct.*	*per ct.*
Cream starter used	Added to cream and ripened	94	94	94.5	92.9	.1	.11	.3
	Added to cream 2 hours before churning ...	95	95	95.5	93.4	.15	.18	.89
Whole milk starter used	Added to cream and ripened...........	93.8	94	94.4	92.2	.1	.12	.32
	Added to cream 2 hours before churning ...	95.5	95.5	95.6	93	.16	.2	.88
Skim milk starter used	Added to cream and ripened	94	94	94.2	92	.1	.12	.3
	Added to cream 2 hours before churning ...	94.3	94.5	95	93.5	.15	.2	.9
Natural starter used	Added to cream and ripened...........	92.8	93	93	93	.14	.15	.35
	Added to cream 2 hours before churning....	92.5	92.7	93	92.5	.16	.17	.9
Commercial lactic acid used	Added to cream when put into churn....	91	91	91	90	.2	.28	.9
	Added to butter and worked into it.....	91	90.9	91	90	.4	.45	1.5
Check churnings	Churned sweet without starter.	89.5	90	90	90.4	.4	.45	1.5
	Ripened normally without starter.....				90.6	.15	.18	.4

TABLE III.

Mixed Cream of Creamery Supply

Average Score 70, acidity .3 per cent.

		SCORE OF BUTTER.				PERCENT OF FAT IN BUTTERMILK.		
		Pasteurized at						
		180° F.	170° F.	150° F.	Unpasteurized.	Churned below 48° F. and warm milk added.	Churned at 50° F.	Churned at 55° F. to 60° F.
						per ct.	per ct.	per ct.
Cream starter used	Added to cream and ripened	91.4	91	91	90	.16	.17	.4
	Added to cream 2 hours before churning ...	93	93	92	91	.2	.22	.9
Whole milk starter used	Added to cream and ripened	91	92	91	90	.16	.16	.4
	Added to cream 2 hours before churning ...	93.7	94	93	90.7	.2	.23	.95
Skim milk starter used	Added to cream and ripened	92.5	91.9	91	89.5	.17	.18	.41
	Added to cream 2 hours before churning ...	93.5	93.2	93	91	.22	.23	.98
Natural starter used	Added to cream and ripened	89.5	89	88.6	88	.2	.21	.45
	Added to cream 2 hours before churning ...	91	90.9	90	88.1	.29	.32	1.1
Commercial lactic acid used	Added to cream when put into churn	90	90	90.1	89	.25	.25	1.3
	Added to butter and worked into it.....	90.1	90.2	90.2	89.5	.45	.5	1.8
Check churning	Churned sweet without starter	87	87.4	87.5	86	.45	.5	1.8
	Ripened normally without stater				85	.21	.25	.45

The averages in the above tables indicate that the butter made from cream which had been pasteurized at 150° F. averaged slightly higher in Table II than that which had been made from cream pasteurized at 185° F., and slightly lower in Table III. This is probably due to the fact that the cream used in Table II instead of being run through a continuous pasteurizer was held for 20 minutes at the temperature at which it was pasteurized, while a continuous pasteurizer was used for the cream of Table III. Holding the cream at high temperature for twenty minutes, or longer, seemed to have a detrimental effect on both the texture of the butter and its keeping qualities.

Immediate cooling proved to be a very important part of the pasteurization, not only in the texture of the butter produced from such cream, but also in the destruction of the bacteria present.

The texture of the butter once destroyed could never be entirely restored by cooling.

The butter made from the best unpasteurized cream when commercial starter was added averaged 92.8 per cent. That of the same kind of cream without starter, 90.1 per cent. A far greater difference is observed in Table II where a poorer grade of cream was used. The keeping quality of the butter was also much better when starter was added. A decided difference is noted between the butter made from natural and commercial culture starters. Natural starters, although carefully selected were very seldom equal to the starters made from commercial cultures, and butter made from cream ripened by them lacked the aroma and keeping qualities of the commercial starter butter.

Cream starters, the use of which eliminates the dilution of cream, proved almost as satisfactory as skim or whole milk starters, 20 per cent cream being used for this purpose. Skim milk starters are beneficial where a heavy cream can be obtained, but in hand separator districts this is not always the case. In fact, some buttermakers experience a great deal of difficulty in obtaining cream that will test higher than 25 per cent. In such instances a 30 per cent or 35 per cent cream starter brings the cream to the proper fat content for churning, while a skim or whole milk starter makes it entirley too thin for best results.

The butter made from cream to which cream starter had been added scored from 92 to 98 and had a good but mild flavor. Skim and whole milk starters, however, usually contained more of the characteristic sharp acid taste. When any of the starters had a flat taste they failed to impart the desired flavor to the butter. Best results were obtained, with starter which contained from .9 per cent to 1.0 per cent of acid and possessed the desired flavor in a pronounced state. In view of the fact that lactic acid forming bacteria develop more readily in cream than in butter, it is more important that starter contain the proper acidity and flavor when added to cream only two hours before churning than when added to cream for ripening. There was less tendency to produce mottles, however, when starter of more than 1 per cent acid was added to cream only two hours before churning. When overripe starter (clabbered until it begins to whey off) was used it formed little white specks in the butter. The acidity also became so high at this point that it destroyed many of the lactic acid bacteria present.

It was found that when starter was added to cream in the churn it failed to impart sufficient flavor and aroma to the butter. Adding the starter immediately after pasteurizing and allowing the cream to cool for at least two hours, during which time it was frequently stirred, permitted the lactic acid bacteria to penetrate the fat globules and thus impart and continue to develop the desired flavor to the resulting butter. Much better results were obtained by the use of pasteurized than with unpasteurized cream by this method.

The amount of starter to be added to cream when churned before ripening, depends upon the acidity of the cream and starter used. The formula adopted by the Guelph Agricultural College of Ontario, Canada, who advocate the method, proved very satisfactory:

SUMMER MAKE

	Per cent.
Acidity of cream	.14
Acidity of starter	1.00
Quantity of starter to be used	.20

WINTER MAKE

Acidity of cream	.14
Acidity of starter	1.00
Quantity of starter to be used	.30

The product of these standards divided by the acidity of the cream and the starter on hand will give the required per cent of starter to be used. Ex.—For summer churning: if the acidity of the cream to be churned is .15 per cent and that of the starter .9 per cent, then; $\frac{14 \times 1.00 \times 20}{.15 \times .9} = 20.74$ per cent starter to be added to the cream.

The use of commercial lactic acid as a substitute for starter proved less satisfactory than good starter, although some of the butter to which it was added scored as high as 94 per cent when made. Its keeping qualities however were not as good as those of the butter from starter ripened cream. It did not have the characteristic strong rancid flavor of normally made improperly stored butter, but a very stale, unpleasant flavor and odor peculiar to itself. Butter made from cream to which lactic acid had been added lacked aroma and had a musty stale taste if more than 3 cc. acid was used per pound of cream. This butter showed less tendency to mould, however, than the check samples where acid was not used.

Buttermilk from sweet cream where no starter had been added was very flat and thin. It was not improved where commercial lactic acid had been substituted for starter. The lactic acid gave it a sour, but also a stale, acid taste. The per cent of acidity increased as readily in the buttermilk from the cream to which lactic acid had been added as in that to which no acid had been added, showing that this acid when added in such small quantities has no appreciable effect upon the growth of lactic acid bacteria. Commercial lactic acid for this purpose (22 per cent) costs 4 cents a pound, f. o. b., Bradford, Pa. The expense therefore is of little consequence.

Sweet cream butter required from one-fourth to one-half ounce more salt per pound of butter than did that of ripened cream. The flavor was also improved by the use of this increased amount of salt, while the aroma remained unaffected.

Butter from cream having a rancid or otherwise "off flavor" was improved from one to three points by washing two and three times (until the rinse water from it was perfectly clear) with pure water and then working commercial lactic acid into it at the rate of 10 cc. to every 5 pounds of butter. The aroma however was usually reduced. The acid was best absorbed by the butter at temperatures above 55° F. The advantage of this system lies in the fact that where pasteurization cannot be done the undesirable flavors may to a certain extent be washed out and some of the desired flavor worked in. In this method there is little danger of excessive washing, as the flavor is in part restored by the addition of lactic acid. Where pasteurization is done still more of the proper flavor may be added to the butter by this method.

A few experiments were also made by adding starter to the butter in the churn and working it in. While practically as much improvement was produced in the flavor by this method as by the addition of lactic acid in a similar manner, the butter was always milky and usually mottled.

The results as will be noticed by the tables show a marked difference in favor of sweet cream churning over that of cream ripening. The average score of all butter from ripened cream in Table III was 90.4. The average score of all butter from the same cream churned after starter had been added only two hours was 95. As far as could be ascertained this difference was due to the effects of undesirable contamination during the process of ripening and handling. Contamination increased with the rise of temperature.

The results as indicated by the tables show a decided difference in the amount of fat lost in the buttermilk from cream churned at different temperatures.

Far more exhaustive churnings were made by churning cream at 50° F. and below than at higher temperatures. The total average percentage of loss of fat in the buttermilk from all cream churned at 48° F. or below was .19 per cent, that of cream churned at 50° F. was .22 per cent, and that of cream churned at from 55° F. to 60° F. was .76 per cent.

During hot weather when small quantities of cream were held at 50° F. for two hours and churned, a considerable amount of fat was lost in the buttermilk. When it was held at lower temperatures, 2½ to 3 hours however, the fat globules became chilled and a much smaller per cent of loss of fat as well as a firmer body resulted. Where the amount of cream churned equaled 25 gallons or more, it did not warm up so rapidly when churning. The smaller the amount of cream the less time required to change its temperature to that of the room in which it is churned. When cream testing less than .2 per cent acid was churned above 50° F. the loss of fat in the buttermilk was proportional to the temperature. The higher the temperature the greater the loss.

When the cream was churned at 48° F. or below the butter failed to gather until the temperature was raised. After churning at this temperature however for 45 minutes to an hour it acquired a somewhat viscous state where upon heating to 50° F. to 60° F., by the use of warm skim milk, or water, the butter gathered almost instantly, two to five revolutions of the churn usually being sufficient to bring it to the proper sized granules. This seems to have solved the problem of sweet cream churning, for the loss of fat in the buttermilk by this method (when starter is used in the cream) was as low or lower than that of sour cream churning. Almost equally exhaustive churnings were made where sweet cream was churned at 50° F., but it required an appreciable amount of ice in summer and steam in winter, also a great deal of the buttermaker's time to obtain this temperature and maintain it while churning.

The advantage of this hot skim milk method is that of being able to churn at any temperature that the cream happens to be when the buttermaker is ready to churn. If it is 50° F., or above, no hot milk need be added. Butter cannot be over-churned by this method, and the body and grain produced by churning at these low temperatures is remarkably good, provided the temperature is not raised above 56° F. by the addition of warm milk. When these temperatures were exceeded the grain and body of the butter was not only injured, but a loss of fat in the buttermilk resulted. The addition of enough warm skim milk or pure warm water to raise the temperature to 56° F. did not materially affect the body of the butter, in view of the fact that fat is a non-conductor of heat and is heated more slowly than the milk serum. Warm skim milk is preferable for this purpose, as it does not dilute the buttermilk.

The addition of warm milk or water exposed the butter of 45° F. to a temperature of 56° F. for one to three minutes only. During this time the temperature of the butter raised from one to two degrees.

For average creamery conditions where the natural temperature is low in winter and high in summer it is advisable to churn at the most convenient temperatures below 60° F. thereby effecting the greatest possible economy of fuel and ice. In cold weather cream may therefore be churned at from 35° F. to 48° F. with the addition of warm skim milk as above described whenever it is desired to have the cream "break." In warm weather cream under average creamery conditions should be churned as soon after reaching the creamery as convenient. If churned without the use of starter or above 53° F. the buttermilk should be passed through the separator and the cream thus obtained should be rechurned.

Where a creamery is supplied with a sufficient amount of ice or refrigeration the above method (churning at 48° F. or below) could be adopted throughout the entire year. In this method the amount of skim milk of a given temperature required to raise that of cream of a given temperature as desired may be found as follows:

Let t = temperature of skim milk, t^1 = temperature of cream, and t^2 = temperature of the mixture. .86 equals the specific heat of skim milk and .78 the specific heat of 30 per cent cream

Sp. heat of cream, .78
Sp. heat of skim milk, .86
t temperature of skim milk
t^1 temperature of cream

t^2 temperature of mixed milk and cream
S skim milk
C cream

Ex. Where 200 pounds of cream at 45° F. are to be raised to 56° F. with skim milk at 150° F:

$$S \times .86 \times (150 - 56) = 200 \times .78 \times (56 - 45)$$
$$S \times 80.84 = 1716$$
$$80.84S = 1716$$
$$S = 21.22 \text{ pounds of skim milk to be added.}$$

The following table was designed for the use of buttermakers and dairymen who desire to adopt this method of churning. The table is constructed without regard to temperature of vats or creamery. Allowance should be made for this.

The numbers in the left-hand column indicate the pounds of cream to be churned; the temperature of the cream is indicated by the top row of numbers. The temperature of the skim milk is 150° F. for convenience. This temperature being most practical for all conditions, as is also 56° F. for the desired temperature of mixture when cream "breaks."

In the use of this table trace the row of figures on the horizontal line from the number of pounds of cream to be churned, until it intersects the vertical row of figures from the temperature of the cream in question. The figure at this point represents the number of pounds of skim milk at 150° F. that are required to raise your cream to 56° F.

For example: we have 200 pounds of cream at 40° F. and after churning half an hour wish to bring the butter. Trace the horizontal line from 200 to where it intersects the vertical line from 40° F. The number at this point is 30.87. Therefore it requires 30.87 pounds of skim milk at 150° F. to raise the temperature of 200 pounds of cream at 40° F. to 56° F.

$$S \times .86 \times (150 - 56) = 200 \times .78 \times (56 - 40)$$
$$S \times 80.84 = 2496$$
$$S = 30.87$$

It will be noticed in this table that the rate of difference is not exactly constant between the number of pounds of skim milk required to raise a given number of pounds of cream of various temperatures to 56° F. This is due to the fact that only hundredth places were used. Had

Amount of skim milk required to raise a given quantity of cream to a desired temperature 56° F. Fahrenheit scale. Temperature of skim milk, 150° F.

AMT. CREAM	35°	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°
Lb.														
25	5.06	4.82	4.58	4.34	4.10	3.85	3.61	3.37	3.13	2.89	2.65	2.41	2.17	1.93
50	10.13	9.64	9.16	8.68	8.20	7.72	7.23	6.75	6.27	5.79	5.30	4.82	4.34	3.86
75	15.19	14.47	13.75	13.02	12.30	11.58	10.85	10.13	9.41	8.68	7.96	7.24	6.51	5.78
100	20.26	19.29	18.33	17.36	16.40	15.43	14.47	13.50	12.54	11.57	10.61	9.64	8.68	7.71
125	25.32	24.12	22.91	21.71	20.50	19.29	18.09	16.88	15.68	14.47	13.26	12.06	10.85	9.64
150	30.39	28.94	27.49	26.05	24.60	23.15	21.70	20.26	18.81	17.36	15.92	14.47	13.02	11.57
175	35.47	33.77	32.08	30.39	28.70	27.01	25.32	23.63	21.95	20.26	18.57	16.88	15.19	13.50
200	40.52	38.59	36.66	34.73	32.80	30.87	28.94	27.01	25.08	23.15	21.22	19.29	17.36	15.43
250	50.39	47.99	45.59	43.19	40.79	38.39	35.99	33.59	31.19	28.79	26.39	23.99	21.59	19.19
300	60.78	57.89	55.00	52.10	49.20	46.31	43.41	40.52	37.63	34.73	31.84	28.94	26.05	23.15
350	70.91	67.54	64.16	60.78	57.40	54.03	50.65	47.27	43.90	40.52	37.14	33.77	30.39	27.01
400	81.04	77.18	73.33	69.47	65.61	61.75	57.89	54.03	50.17	46.31	42.45	38.59	34.73	30.87
500	101.31	96.48	91.66	86.83	82.01	77.18	72.36	67.54	62.71	57.89	53.06	48.24	43.42	38.59

the space permitted or the work in butter making required thousandth parts of a pound of skim milk the tables could be made to reach a definite rate of decrease in numbers from left to right on every horizontal line.

The per cent of water content of the butter was influenced in every instance by the temperatures employed, the per cent of fat being almost constant (30 per cent) in the cream used. Where the temperature of the wash water was higher than that of the butter a higher per cent of moisture was obtained.

Where cream was held at a comparatively high temperature, 55° F. to 60° F., it churned very rapidly. Butter churned in this manner has irregular shaped granules which contain more moisture than the small round granules of butter churned at low temperatures.

The cream churned below 48° F. for an hour and warm milk added produced a combination of the two which gave the proper moisture content, from 12 per cent to 15.8 per cent.

When the temperatures were equal the moisture content of the butter from unpasteurized cream was slightly higher than that of pasteurized cream. No difference in moisture content was noticed between butter made from cream containing skim milk, whole milk, or cream starters.

Where starter was added to the cream two hours before churning the moisture of the resulting butter averaged 12 per cent. That of the butter where lactic acid was added and worked in after washing, 13.5 per cent; where no starter was used, 11 per cent; when the cream was ripened normally, 13 per cent; when it was ripened with starter, 14.5 per cent.

CONCLUSIONS

1. Normal sweet cream may be successfully churned at temperatures below 52° F. when from 20 to 30 per cent of good starter has been added. When churned at higher temperatures or without starter the loss of fat was too great to warrant the adoption of this method.

2. There was slightly less loss of fat in the buttermilk from cream ripened with good starter than from cream to which starter had been added only two hours previous to churning, but the score of the latter was enough higher to more than counterbalance this difference.

3. Natural starters proved less effective than starters made from commercial cultures.

There was practically no difference in the flavors produced in butter by the use of skim milk, whole milk, or cream starters. The cream starters are better adapted for use in thin cream, and skim and whole milk starters are better for use in thick cream.

4. Better results were obtained from pasteurized than from unpasteurized cream of low grade, less difference being noted in high grades of cream.

Immediate and efficient cooling after heating proved to be an essential part of pasteurization, in destroying the bacteria present, and for maintaining the texture of the butter made from pasteurized cream.

5. The use of commercial lactic acid as a substitute for starter proved advantageous only when used in very rancid cream or on butter from such cream after washing the butter thoroughly.

6. A greater loss of fat in the buttermilk resulted from the use of low grades of cream than from high grades of cream by every process of ripening and manufacture employed.

7. The addition of warm skim milk to cream which had been churned at temperatures below 48° F. proved very effective in causing the butter to gather quickly and in securing exhaustive churnings.

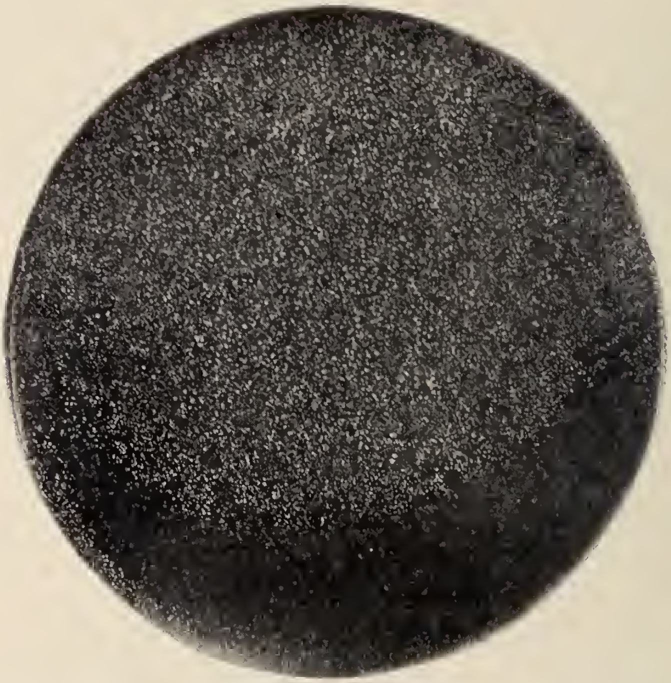


Plate No. I, showing colonies of bacteria developed from $\frac{1}{10}$ cc. of normal unpasteurized cream.

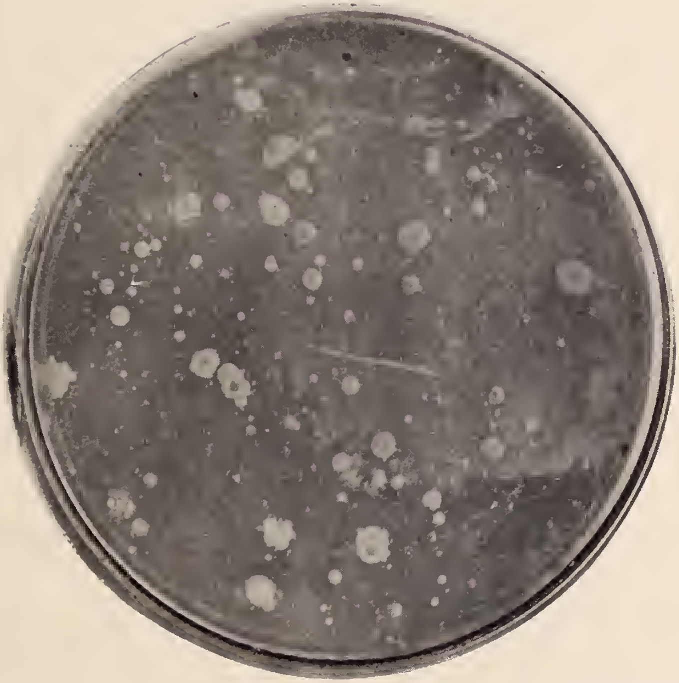


Plate No. II, showing the relatively small number of colonies developed from $\frac{1}{10}$ cc. of cream which had been pasteurized at 155° F., without subsequent cooling.

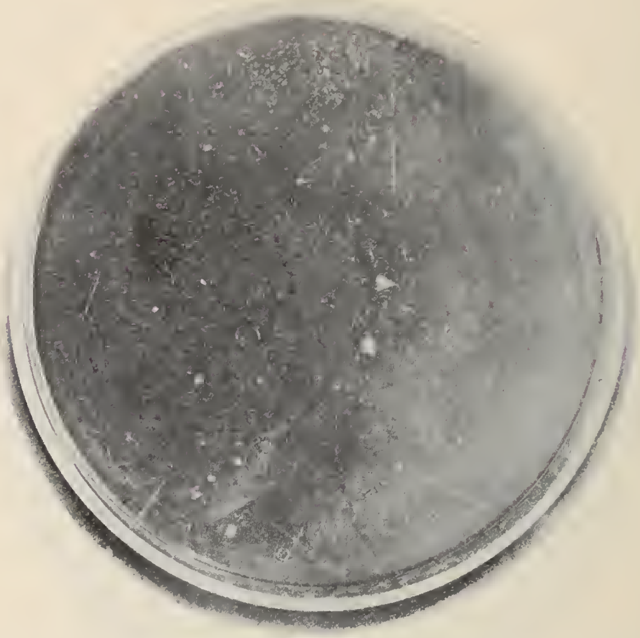


Plate No. III, showing the insignificant number of colonies developed from $\frac{1}{10}$ cc. of cream which had been pasteurized at 155° F. and cooled immediately to 50° F.

Plates Nos. II and III were allowed to develop twelve hours longer than No. I, and the colonies are therefore larger. Plate No. I would not admit of further development without forming a continuous growth over the entire plate.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 136 JUNE, 1909

WHIPPED CREAM

BY C. W. MELICK

Whipped cream is a term applied to cream which has been whipped or beaten into a foam by rapid agitation, the principle being similar to that employed in beating eggs; namely, the incorporation of a considerable volume of air.

A good quality of whipped cream consists of a dense foam of cream which has sufficient body or firmness to enable it to stand up well.

Although large quantities of whipped cream are used for confectionary purposes there is no available data published on investigations along this line.

Baltimore, Washington and many other large cities use a considerable quantity of cream for such purposes and their confectioners frequently experience difficulty in effecting proper whipping.

The following replies to inquiries sent to city confectioners regarding the whipping of cream are of interest in this connection.

1. "We use only separator cream, double cream. You cannot obtain heavy enough gravity cream to whip properly. Pasteurization spoils cream for whipping."

2. "We use gravity cream for whipping. Pasteurized cream will not whip."

3. "We use either separated or gravity cream just so it is thick enough to whip. Pasteurized cream will not whip unless it has been thoroughly chilled."

4. "We don't know whether our cream is separator or gravity. It is double cream. We never tried pasteurized cream for whipping."

The views of each were substantiated by various other confectioners who either concealed their trade secrets or differed in their opinion on this question.

Upon personal inquiry many of them had used separator and pasteurized cream before permitting it to remain long enough at low temperatures. Having been unsuccessful in their attempts to whip such cream they were prejudiced against it.

With a view of ascertaining the causes of difficulties thus encountered, to effect if possible the remedies, and the kind of cream best suited for whipping purposes, the following investigations were conducted to determine:

1. Effect of butter fat content on the whipping quality of cream.
2. Effect of lactic acid on the whipping quality of cream.
3. Effect of pasteurization on the whipping quality of cream.
4. Effect of temperature on the whipping quality of cream.
5. Effect of centrifugal separation on the whipping quality of cream.
6. Effect of sugar on the whipping quality of cream.
7. Effect of salt on the whipping quality of cream.
8. Effect of dried milk powder on the whipping quality of cream.
9. Effect of viscogen on the whipping quality of cream.
10. Effect of gelatine on the whipping quality of cream.
11. Effect of junket on the whipping quality of cream.
12. Effect of cornstarch on the whipping quality of cream.
13. Effect of vanilla on the whipping quality of cream.
14. Effect of caramel on the whipping quality of cream.
15. Effect of egg albumen on the whipping quality of cream.
16. Effect of lactation period on the whipping quality of cream.

The cream used in every experiment was whippd in 50 cc. sample lots in a 400 cc. porcelain mortar, with a Dover egg beater so as to subject each sample to similar conditions.

Normal sweet gravity cream was taken as a standard and whipped in comparison with separator and pasteurized cream, and with cream to which each of the above ingredients had been added.

EFFECT OF BUTTER FAT CONTENT ON THE WHIPPING QUALITY OF CREAM

Samples of fresh, normal cream right from the separator, containing from 15 to 50 per cent butter fat would not whip immediately after cooling to 40° F. Cream from one to forty-eight hours old containing less than 20 per cent fat and less than 0.25 per cent acid would not whip at temperatures above 40° F. Cream containing 20 per cent or more of butter fat and having been held at 40° F. or below for at least one hour whipped without difficulty.

In the following table each sample of cream contained 0.15 per cent acid and had remained at 45° F. for two hours,

Per cent fat in cream	20	25	30	35	40
Average time required to whip	1m. 40s.	1m.	50s.	35s.	25s.

Other conditions being equal there was an almost definite ratio between the fat content and time required to whip.

THE EFFECT OF LACTIC ACID ON THE WHIPPING QUALITY

The older the cream up to the point of separation of whey from clabber the better it whipped. For this reason gravity cream of the same fat content whipped better than fresh separator cream, twelve hours usually being required to raise. This was accompanied by a development of 0.2 to 0.3 per cent of lactic acid. Samples of cream were also whipped with and without commercial lactic acid so as to overcome any changes which would occur were the cream allowed to remain at various temperatures while lactic acid increased naturally. In every instance the cream to which commercial lactic acid had been added whipped in less time and produced a denser foam than did that to which no acid had been added.

Five-tenths per cent of commercial lactic acid, or cream testing three-tenths per cent normal acid, was the maximum quantity necessary to produce best results. This is approximately one teaspoonful of acid to two teacupfuls of cream. Cream containing this amount of acid and only 10 per cent of fat whipped at temperatures below 45° F. after having been held at such temperatures for two hours or more.

Lactic acid either natural or commercial at low temperatures effected a gelatinous consistency of the casein and albumin of the cream, which rendered it capable of holding a considerable quantity of air, thus facilitating whipping.

In the table on the following page each sample of cream had been held at 45° F. for two hours.

Here the effect of lactic acid proved to be of greater importance than that of the fat content. The fat content proved the more important factor until cream reached 20 per cent. Above this point the acid content was the more important. Three-tenths of a per cent of acidity is the maximum which cream may contain without acquiring a sour taste.

Time Required to Whip Cream of Varying Acidity

Per cent acid in cream..	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Per cent Fat										
15...............							1m. 30s.	1m. 20s.	1m.	50s.
20...............	1m. 50s.	1m. 30s.	1m. 20s.	1m. 10s.	1m.	50s.	42s.	34s.	30s.	30s.
25...............	1m. 10s.	55s.	50s.	41s.	37s.	32s.	28s.	25s.	23s.	23s.
30...............	55s.	45s.	40s.	37.s	34s.	30s.	26s.	23s.	22s.	22s.

The addition of commercial lactic acid in small quantities had no effect on the natural development of acid.

EFFECT OF PASTEURIZATION AND TEMPERATURE ON THE WHIPPING QUALITIES OF CREAM

Samples of cream were pasteurized at temperatures varying from 140° F. to 185° F. and cooled to 50° F., 45° F., and 40° F. Although these samples contained from 20 per cent to 50 per cent butter fat none of them would whip immediately after pasteurizing. After remaining at a low temperature until the milk solids congealed, pasteurized cream whipped as readily as did unpasteurized cream. This congealing in case of the fat globules required an average of 35 minutes at 40° F., an hour at 45° F., and two hours at 50° F., when placed in water at these temperatures in pint milk jars. The other solids congealed much more rapidly. The time was taken as soon as the samples had actually reached the above temperatures, which required only a few minutes. When allowed to cool in the air as a medium the process was slow. In such instances the fat globules congealed while the other solids were cooling, and the cream was ready to whip as soon as cooled.

The smaller the quantity in proportion to exposed surface the less time required to cool in a cold medium. Pasteurization therefore has no permanent detrimental effect upon the whipping qualities of cream.

Samples of cream were also heated to 80° F. and placed in 250 cc. (1 teacupful) lots, in flat pans ten inches in diameter, and in beakers two and five-eighths inches in diameter and three and one-half inches deep. They were allowed to remain in rooms of various temperatures until whipping could be effected. An average of the results thus obtained are summarized in the following table.

The table illustrates the difference in the time required to cool cream of different percents of fat, and varying in exposed surface. The samples contained 250 cc. each and were brought to a temperature of 80° F. at the time they were put into the various vessels. The shallow pans were ten inches in diameter, and the cream when poured into them was one-fourth inch deep. The beakers as above described contained the same quantity of milk as the shallow pans, but the volume was two and five-eighths inches in diameter and three and one-half inches deep.

From these results it will be readily seen that the richer the cream the more time required to cool, and that an almost constant ratio exists between the density of the cream and the rate of cooling. This proved

		TEMPERATURE OF ROOM											
		40° F.				45° F.				50° F.			
Per cent fat in cream		20	23	26	30	20	23	26	30	20	23	26	30
Time required to cool to room temperature in	shallow pans	1h. 30m.	2h.	2h. 25m.	2h. 50m.	2h.	2h. 20m.	2h. 40m.	3h. 10m.	2h. 40m.	3h.	3h. 24m.	3h. 50m.
	beakers	4h.	4h. 30m.	5h.	5h. 30m.	4h. 30m.	5h.	5h. 30m.	6h. 55m.	4h.	5h. 20m.	5h. 50m.	6h. 30m.
Time required for fat globules to congeal sufficiently to whip normally in	shallow pans	1h. 45m.	1h. 55m.	2h. 8m.	2h. 25m.	1h. 50m.	2h. 10m.	2h. 30m.	2h. 40m.	2h.	2h. 20m.	2h. 50m.	3h.
	beakers	4h.	4h. 30m.	5h.	5h. 30m.	4h. 30m.	5h.	5h. 30m.	6h.	4h. 55m.	5h. 20m.	5h. 50m.	6h. 30m.

true only where the atmosphere of the room remained constant. When the room temperature was lowered, where the air was stirring, or a draught was present, the cream cooled much more rapidly than in the cases cited in the above table.

When whipped, after remaining at these temperatures less time than this, the pasteurized cream and separated cream which had been heated required more time for whipping than did the unpasteurized or unheated gravity cream.

The difference in the whipping quality of warm and cooled cream proved to be due to the more viscous condition of the cold cream caused by the congealing of the casein and albumin, in which condition more air is incorporated in whipping.

The temperature of the room in which cream was whipped had a marked influence upon its whipping quality. When whipped in a room with a temperature of 70° F. cream at 50° raised to 68° F. by the time whipping was effected. When cream of a low fat content or otherwise difficult to whip was vigorously beaten in a room of 65 to 70° F. it invariably failed to whip.

EFFECT OF CENTRIFUGAL SEPARATION ON WHIPPING QUALITY OF CREAM

Centrifugal and gravity cream of identical composition were whipped at various temperatures immediately after separating, and after having been allowed to remain at low temperatures from ten minutes to three hours.

No difference could be noted in their whipping qualities after the milk solids were allowed to congeal. Milk is usually separated at from 60° to 100° F. and the cream coming from the separator at such temperatures would not whip. Neither would gravity cream whip at those temperatures. Gravity cream skimmed in the normal way without heating naturally required less cooling. Centrifugal force had no detrimental effect upon the whipping quality of cream and the heating which it necessitated had no permanent detrimental effect on it.

To further substantiate the uniformity of results obtained by the use of separator and gravity cream when properly cooled and the results obtained by the use of commercial lactic acid, samples of normal gravity cream numbered 1, gravity cream containing 1 per cent acid numbered 2, normal separator cream numbered 3, and separator cream containing one per cent of acid numbered 4, all of the same fat content, were sent to several confectioners for their opinion of the comparative whipping qualities.

The following is a summary of the five replies received:

Numbers 2 and 4 whipped in less time and had a stiffer foam in every instance with but one exception, in which number 3 was reported to have been whipped in the same length of time as numbers 2 and 4.

The time required to whip numbers 1 and 3 from all replies averaged exactly the same. The average time required to whip numbers 2 and 4 showed only 6 seconds difference. The average difference between the time required to whip numbers 2 and 4 and 1 and 3 was 1 minute and 14 seconds, various amounts and temperatures being used by different confectioners.

EFFECT OF SUGAR, SALT AND DRIED MILK POWDER ON THE WHIPPING QUALITY OF CREAM

Each of the powdered substances used facilitated whipping by reducing the per cent of water content, and when cooled by rendering the cream more viscous. The sugar, casein and albumin of the milk powder, and the action of the salt on the casein increased the viscosity of the cream to which they were added.

The more viscous the cream the more readily it incorporated air at low temperatures.

Each powdered substance aided slightly in lessening the time of whipping, and in some instances caused cream to whip which otherwise would not.

No difference could be noted in the whipping qualities of cream to which milk sugar, powdered cane sugar, or dried milk powder had been added, and since powdered sugar is cheaper than either of the other products only the detailed results of its use is reported in the tables.

EFFECT OF VISCOGEN ON THE WHIPPING QUALITY OF CREAM

Viscogen or sucrose of lime, is made by adding two and one-half parts of sugar, or all that will dissolve, to five parts of water and three-tenths part milk of lime. Mix thoroughly and allow to stand 24 hours before using.

It is called viscogen because of its tendency to restore the viscosity in pasteurized cream immediately after pasteurizing. Pasteurization at 150° F. or above reduces the viscosity of cream temporarily either by loosening the galactase which holds the fat globules in groups or by causing a disarrangement of the calcium salts of milk or both. This disarrangement is gradually restored to a normal state by allowing such cream to remain for several hours at low temperatures. It is rapidly restored, however, by the addition of lime-water of viscogen. The sugar of the viscogen furnishes food for the lactic acid producing bacteria and by their growth the lactic acid is increased.

Pasteurized cream, as was repeatedly demonstrated, should therefore be allowed to cool for several hours before whipping. For best results if it contains less than 0.2 per cent of acid, it should be inoculated with a small amount of lactic acid starter or have 0.5 per cent to 1.0 per cent of commercial lactic acid added.

Viscogen is an alkali and neutralizes the acidity of cream to which it is added and thus delays souring. When made of commercial lime not over two ounces could be used in five gallons of cream without causing an undesirable odor and bitter taste. Two ounces of viscogen combined with a low temperature proved sufficient to restore the viscosity in five gallons of sweet cream.

The viscosity of pasteurized cream was restored equally as well in these investigations by holding it at low temperatures for several hours longer without the use of viscogen as when the latter was used.

The viscogen used in these experiments was made of chemically pure lime-water. Viscogen thus made may be used in larger quantities than that made from ordinary commercial lime, without injuring the flavor of the cream to which it is added. It was found necessary to use 1 per cent of viscogen in cream which was to be whipped immediately after adding.

EFFECT OF CARBON DIOXIDE ON THE WHIPPING QUALITIES OF CREAM

Carbon dioxide (CO_2) is the gas which is given off from baking soda. It is the gas which is used in soda-water to produce the sparkle and foam. In obtaining it for this work baking soda was treated with sulphuric acid and the CO_2 which was liberated was conducted into the cream. In these tests gravity, separator and pasteurized cream was used.

There was no apparent difference in the whipping quality of cream saturated with CO_2 and untreated cream. Cream saturated at low temperatures, however, produced a foam which remained sweet longer than did that of untreated cream.

The addition of this gas at 60° F. merely lessened the keeping quality of the cream. At that temperature only a small amount of the gas seemed to be retained, and holding cream at such a high temperature long enough to saturate it proved detrimental to its keeping qualities. The lower the temperature the more CO_2 was incorporated and the better was its keeping quality.

The amount of CO_2 that was incorporated into cream even at low temperatures, however, without pressure aided its keeping quality only slightly.

Van Slyke and Bosworth of the Geneva Experiment Station subjected milk to carbon dioxide gas under pressure of 70, 150 and 175 pounds per square inch, with the following results: Application of CO_2 at 70 pounds pressure delayed the souring of milk beyond the eighth day, and at 150 pounds pressure it made no increase in acidity in nine months.

Mowry and Michel[1] state as a result of some of their work that milk saturated with carbon dioxide would keep at a low temperature for eight days. They also state that the effect of carbon dioxide is merely to check the growth of the bacteria. The bacteria are not killed.

Foa[2] investigated the action of carbon dioxide gas under pressure of thirty to seventy-five pounds upon various organisms and found that it had a checking influence upon the development of organisms but does not act on enzymes or toxins. Under sixty pounds pressure it checked alcoholic fermentation.

Hoffman[3] treated fresh milk with carbon dioxide under pressure of 750 pounds for several hours. Bacteria present in the milk were capable of growth after the milk was relieved from pressure.

Van Slyke and Bosworth also found "that the addition of sucrose alone did not delay the souring of milk, that the addition of yeast alone apparently delayed the fermentation of acid slightly, that the addition of yeast and five grams of sucrose did not reduce the acidity much below that of milk to which yeast alone was added, that the addition of larger amounts of sugar along with yeast delayed the souring of milk to such extent that coagulation did not occur for five or six days or longer."

From this the advantage of carbon dioxide in whipped cream is obvious. It will not aid in whipping, but if introduced under pressure, and held under pressure after whipping, the cream may be retained sweet for a considerable length of time.

EFFECT OF GELATINE, JUNKET AND CORNSTARCH ON THE WHIPPING QUALITY OF CREAM

The use of gelatine, junket and cornstarch facilitated whipping of cream at from 45° to 60° F., and gelatine and cornstarch caused it to stand up better in the temperature of the average room, which is 70° F.

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[1] Compt. Rend., 115, 959–960, 1892.

[2] Chem. Centbl. 77, 11: 695. 1906.

[3] Arch. Hyg. 57: 379. 1906.

Temperatures below 45° F. were as effectual as the addition of any of these ingredients; at temperatures above 60° F. cream failed to whip even with the addition of one or more of the ingredients. These ingredients were added to the cream in a liquid state and allowed to thicken, forming the cream into a jelly-like mass. 10 per cent of gelatine, 20 per cent of cornstarch and one junket tablet per quart of cream were the maximum amounts required to produce the best results.

A comparison of their effect on the whipping quality is given in the general summary.

EFFECT OF CARAMEL ON THE WHIPPING QUALITY OF CREAM

The caramel used in these experiments was made by heating granulated sugar while stirring until it melted and turned dark brown. At this point an equal quantity of boiling water was added and the whole allowed to boil into a syrup. When cooled it could be poured with difficulty. In this condition air was readily incorporated into it by whipping. The addition of 10 per cent of caramel imparts a very pleasing flavor, and facilitates whipping between 45 and 60° F.

For comparison of effect of caramel with other ingredients see summary.

EFFECT OF EGG ALBUMEN (WHITE OF EGG) ON THE WHIPPING QUALITY OF CREAM

The addition of egg albumen at 40° F. or above, unless whipped before adding, retarded the whipping of cream to which it had been added. At temperatures below 40° F. when added with a few drops of lactic acid it did not retard the whipping, but tended to produce a lighter foam.

The effect of lactic acid on albumen, although slight in comparison to its effect on casein, produced a somewhat gelatinous consistency which aided the incorporation of air in whippng.

EFFECT OF VANILLA EXTRACT ON THE WHIPPING QUALITY OF CREAM.

In view of the fact that vanilla flavoring is used extensively in confectionary products its effect on the whipping quality of cream was determined.

The vanilla extract used in these investigations contained 8.4 per cent dilute alcohol. Alcohol has a great affinity for water and naturally absorbs small quantities of it from most substances to which it is added.

Five drops of the extract were used in 50 cc. of cream. In such small quantities it had practically no effect on the whipping quality of cream.

THE QUANTITY OF THE VARIOUS INGREDIENTS WHICH MAY BE ADDED TO CREAM

The per cent of ingredients used in the experiments from which the following table was compiled represents the amount of each that was used without injury to the taste or flavor of the whipped cream for any or all purposes.

The percentages used were as follows: 1 per cent of powdered sugar, 0.5 per cent of salt, 0.5 per cent of lactic acid, 1 per cent of viscogen, 10 per cent of caramel, 10 per cent of gelatine, 20 per cent of cornstarch, one junket tablet per quart of cream, five drops of vanilla extract per 50 cc. of cream, and where carbon dioxide was used the samples of cream were saturated at a temperature of 45° F.

For the convenience of those who have no facilities for measuring and have no time to figure percentages, the following may be helpful.

½ per cent = 1 teaspoonful to 4 teacupfuls, approximately.
1 per cent = 1 teaspoonful to 2 teacupfuls, approximately.
2 per cent = 1 teaspoonful to 1 teacupful, approximately.
10 per cent = 1½ tablespoonfuls to 1 teacupful, approximately.
20 per cent = ⅕ teacupful to 1 teacupful, approximately.

The average acidity of the cream used in the following table was 0.2 per cent with an average fat content of 30 per cent. The average temperature was 50° F. The samples were all held at this temperature for three hours. The average temperature of the room in which the cream was whipped was 55° F.

It will be noticed in the preceding table that the samples of unwhipped cream remained sweet longer than did the samples of whipped cream.

The excessive amount of air incorporated in the whipped cream increases its bulk and reduces its density, thereby producing a more favorable condition for bacterial growth.

There was no apparent difference in the acid development of whipped and unwhipped cream until after 12 hours. The whipped cream then began to show an increased per cent of acid.

None of these ingredients except lactic acid facilitated the whipping of cream which had been held at 40° F. or below. This temperature together with the results obtained from it, was in itself sufficient.

Cooling, therefore, proved to be of far more importance than the addition of any ingredient except lactic acid.

Table Showing the Effects of the Addition of Various Ingredients on the Whipping Quality of Separator and Gravity Cream

	PLAIN CREAM.	POWDERED SUGAR.	SALT.	LACTIC ACID.	VISCOGEN.	CARBON DIOXIDE.	GELATINE.	JUNKET.	CORNSTARCH.	VANILLA.	CARAMEL.
Time required to Whip in seconds.											
Separator Cream	50	41	42	25	30	50	40	40	45	49	45
Separator cream, pasteurized	50	40	40	25	30	50	41	40	44	50	44
Gravity cream	50	40	42	25	30	50	40	40	45	50	45
Gravity cream, pasteurized	51	40	41	26	30	50	40	40	45	49	45
Acidity of whipped cream at end of 24 hours at 55° F.											
Separator cream	0.26	0.26	0.26	0.25	0.22	0.24	0.3	0.27	0.28	0.23	0.28
Separator cream, pasteurized	0.25	0.24	0.25	0.25	0.21	0.23	0.3	0.28	0.28	0.23	0.28
Gravity cream	0.26	0.25	0.26	0.26	0.22	0.24	0.3	0.28	0.28	0.23	0.28
Gravity cream, pasteurized	0.24	0.23	0.24	0.24	0.21	0.23	0.3	0.28	0.28	0.23	0.28
Acidity of whipped cream at end of 48 hours at 55° F.											
Separator cream	0.33	0.33	0.33	0.31	0.25	0.3	0.36	0.32	0.33	0.26	0.34
Separator cream, pasteurized	0.3	0.31	0.31	0.3	0.24	0.28	0.36	0.32	0.33	0.26	0.34
Gravity cream	0.32	0.32	0.33	0.31	0.25	0.29	0.36	0.32	0.33	0.26	0.34
Gravity cream, pasteurized	0.29	0.3	0.31	0.29	0.24	0.27	0.36	0.32	0.33	0.26	0.33
Acidity of unwhipped cream at end of 48 hours at 55° F.											
Separator cream	0.31	0.31	0.30	0.29	0.22	0.28	0.33	0.3	0.3	0.24	0.31
Separator cream, pasteurized	0.27	0.28	0.28	0.28	0.22	0.26	0.32	0.3	0.3	0.24	0.31
Gravity cream	0.30	0.30	0.30	0.29	0.22	0.27	0.33	0.3	0.3	0.24	0.31
Gravity cream, pasteurized	0.26	0.28	0.29	0.27	0.22	0.26	0.32	0.3	0.29	0.24	0.3

The amount of powdered sugar, salt, viscogen, or lactic acid that may be used in cream for confectionary purposes depends entirely upon the amount of flavoring and sweetening that is desired. In fruit puddings, for instance, where sugar and spices are used with fruit, larger quantities of the above ingredients may be used in the whipped cream coating without affecting the taste of the product.

The heaviest cream generally produced the heaviest foam when whipped.

It is difficult to obtain gravity cream that will test 30 per cent fat or above. Cream testing less than this contains such a large per cent of water which has to be overcome in whipping that it cannot be done satisfactorily unless it has been held at a very low temperature for several hours.

While there is practically no difference in the keeping quality of the untreated cream and that treated with salt, milk sugar, or lactic acid, in the quantities here used, the cream treated with viscogen and carbon dioxide remained sweet from twelve to twenty-four hours longer.

From these observations it is evident that the success of whipping cream depends upon the congealing of the solids contained therein, and the development of a small amount of lactic acid.

EFFECT OF LACTATION PERIOD ON THE WHIPPING QUALITY OF CREAM.

Cream from cows nearing the end of their lactation period whipped with much more difficulty than did cream from cows near the beginning of their lactation period. This is probably due to the physical condition of the milk solids, especially the fat globules which at this period are smaller and harder than in the earlier part of the lactation period.

Sixteen cows from the Station herd were used in this experiment, including Holsteins, Jerseys, and grades. Eight of these were almost dry, giving from one quart to one gallon of milk a day per head. The other eight cows were practically fresh, having calved from two months to a week before the experiment began. The same number of each breed was used in each group to eliminate any possibility of breed variations.

The following table illustrates the average differences found in whipping quality of cream, due to differences in lactation period.

The temperature, per cent of fat, and acid were the same in both groups in each experiment.

Time Required to Whip

PER CENT FAT.	CREAM FROM COWS AT THE BEGINNING OF LACTATION PERIOD.	CREAM FROM COWS NEAR THE END OF LACTATION PERIOD.
25	1m.	1m.25s.
30	50s.	1m.10s.
33	40s.	55s.
37	30s.	50s.

The cream used in the above tests was obtained both by gravity and by centrifugal separation, no difference being noted in their whipping qualities when properly cooled, and of the same acid content.

Summary.

These investigations indicate that the whipping of cream depends upon a number of points and that some of the additions which are made to cream which is used for whipping are beneficial while others contribute little to its value for this purpose.

The principal points brought out by the investigation may be classified as follows:

1. There was no difference in the whipping qualities of gravity and separator cream. When any difference is experienced it is due to other factors and not to the method of getting the cream from milk.
2. Cream for whipping purposes should contain at least 20 per cent butter fat. The best results were obtained with cream containing from 25 per cent to 40 per cent butter fat.
3. For best results cream should be held at as low a temperature as possible (35° to 45° F.) for at least two hours before whipping, and should be whipped in a cool room.
4. For good results cream should be from 12 to 24 hours old. This gives an opportunity for the development of a small amount of acid in the cream. The acid effected a gelatinous consistency in the casein and albumin and thus facilitated the incorporation of air in whipping. When it is desired to whip fresh cream 3/10 per cent commercial lactic acid may be added to take the place of the acid which would develop by setting the cream from 12 to 24 hours.
5. Pasteurized cream may be whipped as easily as unpasteurized cream if it is thoroughly cooled and held at 35° to 45° F. for at least two hours before whipping.

6. For good results cream should whip in from 30 to 60 seconds. When a longer time is required there is danger of some of the butter fat separating or churning.

7. The addition of one-tenth to three-tenths per cent of commercial lactic acid to cream facilitated its whipping and made it possible to whip cream which was fresher, which contained less butter fat and which was warmer than is advisable for the best results.

8. The use of viscogen facilitated the whipping of cream to a greater extent than any other ingredient with the exception of lactic acid. It proved less effective than the latter and also less effective than a low temperature. The addition of viscogen caused cream to remain sweet from 12 to 24 hours longer than it otherwise would.

9. The use of powdered sugar, powdered milk, salt, caramel, gelatine, junket, and cornstarch, each facilitated the whipping of cream to a small degree, and each to practically the same extent. None of them proved as effective as a low temperature and the development or addition of lactic acid. The addition of an excess of gelatine above 10 per cent or of cornstarch above 20 per cent caused a lumpy cream when whipped.

10. The use of egg albumen with cream when whipped separately and mixed, produced a lighter foam, but had no effect upon the time required to whip. When mixed before the egg albumen was whipped, at temperatures above 40° F., the whipping was retarded.

11. The use of vanilla extract used in ordinary quantities had no effect upon the whipping qualities of cream.

12. The charging of cream with carbonic acid gas without pressure had no effect on its whipping qualities but caused it to remain sweet from 12 to 24 hours longer.

13. The use of cream from cows near the end of their lactation period whipped with slightly more difficulty than did cream from fresh cows.

14. Whipped cream will not keep sweet as long as unwhipped cream.

15. When any additions are made to cream to facilitate whipping it should be so labeled as to not deceive the purchaser.

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